Instream Flows Needed for Successful Migration and Rearing of Rainbow and Westslope Cutthroat Trout in Selected Tributaries of the Kootenai River

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INSTREAM FLOWS NEEDED FOR SUCCESSFUL MIGRATION, SPAWNING, AND REARING OF RAINBOW AND WESTSLOPE CUTTHROAT TROUT IN SELECTED TRIBUTARIES OF THE KOOTENAI RIVER

Final Report FY 1988

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EXECUTIVE SUMMARY

This is the second phase of a two-part study that was conducted by Montana Department of Fish, Wildlife and Parks in contractual agreement with Bonneville Power Administration to address measure 903(a)(7) (formerly 804(a)(9)) of the Northwest Power Planning Council's River Basin Fish and Wildlife Program. Objectives were to determine instream flow needs in Kootenai River tributaries to maintain successful fish migration, spawning and rearing habitat of game fish, evaluate existing resident and rearing fish populations, and compile hydrologic and fishery information required to secure legal reservation of water for the fishery resource.

The Kootenai River fishery is threatened by microhydro and other water use development which reduce tributary habitat critical for maintaining a healthy spawning and rearing environment. The wetted perimeter method was used to estimate flows required to maintain existing resident and migratory fish populations in 28 tributaries to the Kootenai River. Migrant passage flows were determined using the discharge-average depth relationship at four (usually five) riffle transects. This information will provide the basis to reserve water through application to the Montana Department of Natural Resources and Conservation.

Electrofishing during the fall, in stream reaches where instream flow measurements were made, indicates the relative potential for production of recruits in the various streams. The location of some sampling sections within low stability channels near the tributary mouths may have resulted in underestimates of fish populations farther upstream. Fishing pressure in easily accessible areas may also have artificially reduced fish populations in portions of some reaches. Estimates of resident and pre-emigrant *Salmo* spp. were highest in Big Cherry Creek (1,227 $\pm$ 131 per km), followed next in abundance by Seventeenmile Creek (982 $\pm$ 57 per km). Cripple Horse, East Fisher, Sinclair, Swamp creeks and the North Fork of the Yaak River also contained more than 500 fish $\geq$ 75 mm per km.

Flow measurements ranged from 0.2 cfs in Canyon Creek to 634.3 cfs in Lake Creek. Basal flows in many of the study streams are typically lower than optimal for fish production during portions of some water years, even without the effects of consumptive water uses. Cumulative effects of present water appropriations, in many stream reaches grossly over-allocated, could degrade the fishery resource if water users exercise their water rights to the fullest extent. It is unknown, however, what percentage of existing claims are valid or presently in use. Recommended instream discharges were set at the level needed to maintain present fish stocks in the Kootenai system. No water should be removed by water users with junior priority dates when natural flows decline below

the recommended limits and senior water users should be encouraged to conserve water.

Sediment pollution, toxic contaminants and channel instability caused by man's activities in the drainage continue to threaten the health of the fishery resource. Point and non-point sediment loading are apparent in nearly all of the study streams due to timber harvest practices and road construction. Inadvertent spills and seepage from mine tailing and settling ponds, which may contain toxic materials, have been documented in some streams.

Deltaic materials are accumulating at the mouths of tributaries entering the Kootenai River below Libby Dam due to a regulated reduction of peak flow events. Dunn, Libby, Pipe and Quartz creeks have deposited substantial deltas which historically were redistributed by high river flows. Although migrant passage into these streams does not appear to be inhibited at present, continued deposition may eventually impede natural reproduction in some streams. Migrant bull trout may be particularly sensitive because their fall spawning run coincides with low tributary flows and reduced channel depths. Standard surveying techniques were used to document the present elevation and area of the Quartz Creek delta. The method is inexpensive and reproducible, and should be repeated on a five- to ten-year basis.

INTRODUCTION

In recognition of the harmful effects of hydropower development on fishery habitat, the Northwest Power Planning Council (1982) under direction of the Northwest Power Act of 1980, developed a plan " . . . to protect, mitigate and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries." The program was designed to deal comprehensively with the Columbia drainage system; the Kootenai River is the second largest tributary. This final report is the second of a two-phase research effort funded by the Bonneville Power Administration and performed by the Montana Department of Fish, Wildlife and Parks (MDFWP) to address measure 903(a)(7) (formerly 804(a)(9)) of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program. The first report (Marotz and Fraley 1986), recommended that "major forks of the tributaries . . ., and upper stream reaches exhibiting dissimilar hydrologic characteristics should be researched to clarify instream flow needs." Additional stream reaches, identified as containing important or sensitive fishery habitat by MDFWP and U.S. Forest Service personnel, were included to complete a basin-wide investigation of the Kootenai River drainage of Montana.

The Kootenai watershed is a high water-yield drainage and tributaries have been targeted for microhydro and irrigation development, both of which could reduce available habitat required to maintain the valuable fishery resource. Fisheries production in tributary streams is related to the amount of insect production, bank cover, and fish spawning and rearing habitat. When discharge declines, stream flow recedes from the riffle areas, potentially reducing food production, and spawning and rearing habitats. Thus, the wetted perimeter-discharge relationship for riffles can be an important parameter in the assessment of fisheries needs (Leathe and Nelson 1986). It is important that instream flow requirements of game fish species be determined so that fisheries needs can be balanced with those required for power and irrigation facilities.

Twenty-eight streams in the Kootenai basin were investigated in this study. These streams supplement those investigated by May (1982), and Marotz and Fraley (1986), and by increasing the sample points within previously studied subdrainages, raise the level of resolution in the analysis of the Kootenai basin. The 28 streams are arranged either by subdrainage groups, or individually for those that flow directly into the Kootenai River.

Species abbreviation and popular game fish referred to throughout this document are as follows: westslope cutthroat trout, *Salmo clarki lewisi* (WCT); rainbow trout, *Salmo gairdneri* (RB); rainbow and cutthroat hybrids (HYB); bull trout (inland Dolly Varden), *Salvelinus confluentus* (DV); kokanee salmon,

Oncorhynchus nerka (KOK); eastern brook trout, *Salvelinus fontinalis* (EBT); northern mountain whitefish, *Prosopium williamsoni* (MWF); and the burbot, *Lota lota* (LING).

This phase of the project began in March, 1987, with the following objectives:

1) To complete a basin-wide instream flow investigation in the Kootenai River drainage of Montana by determining discharge requirements for maintenance of fish production in 28 streams, deemed important fishery habitat, which had not been previously studied.

2) Evaluate existing resident and rearing fish populations in the tributary reaches where the instream flow measurements were made, and assess potential barriers to migrant spawners.

3) Compile available hydrologic and fishery information required to secure legal reservation of instream flows.

STUDY AREA

The Kootenai River, the second largest tributary to the Columbia River, originates in Kootenay National Park near Banff, British Columbia. The river enters Montana near Rexford, Montana, flows southward through the Purcell and Salish mountains and enters the reservoir created by Libby Dam. Below the dam at Libby, Montana, the river turns northwest along the Cabinet Mountain range and crosses the Idaho border near Troy, Montana. The Kootenai is approximately 780 km long and flows into the Columbia River at Castlegar, B.C.

The drainage basin is characterized by north to northwest trending mountain ranges composed of faulted and folded crustal blocks of metamorphosed sedimentary rocks of the Precambrian Belt Series and minor basaltic intrusions. The area is typified by rugged, steep mountain slopes and narrow valleys. As much as 90 percent of the Kootenai basin is coniferous forest; a small amount (about 2 percent) is agricultural land used mainly for pasture and forage production (Bonde and Bush 1982).

Of the approximately 49,987 km^2 in the Kootenai drainage, runoff from 4,301.5 km^2 enters the Kootenai from the twenty-eight tributaries under investigation. Figure 1 shows the relative location of major tributaries reported here, and by Marotz and Fraley (1986). Individual stream descriptions are included in their respective sections of this report.

The Tobacco River subdrainage exhibits the greatest potential for dewatering of all major Kootenai tributaries in Montana. Precipitation is low in the basin, averaging about 35 inches per year. The gentle valley bottom topography is conducive to ranching, residential development and recreational facilities such as golf courses. Gross over-appropriation of water rights for irrigation and domestic use is common. The Tobacco River system is the largest spawning and rearing tributary to Libby Reservoir south of the Canadian border.

Smaller tributaries that enter the Kootenai drainage above Libby Dam also provide important spawning and rearing habitat, and sustain trout populations in the reservoir. Most reservoir tributaries including the North and South forks of Big Creek, Cripple Horse and Canyon creeks, drain land managed by the U.S. Forest Service for timber production.

Dunn Creek flows directly into the Kootenai River and is the only tributary used for spawning other than the Fisher River system for 27 km below Libby Dam.

The Fisher River subdrainage is the first of four major tributaries in Montana which enter the Kootenai River below Libby

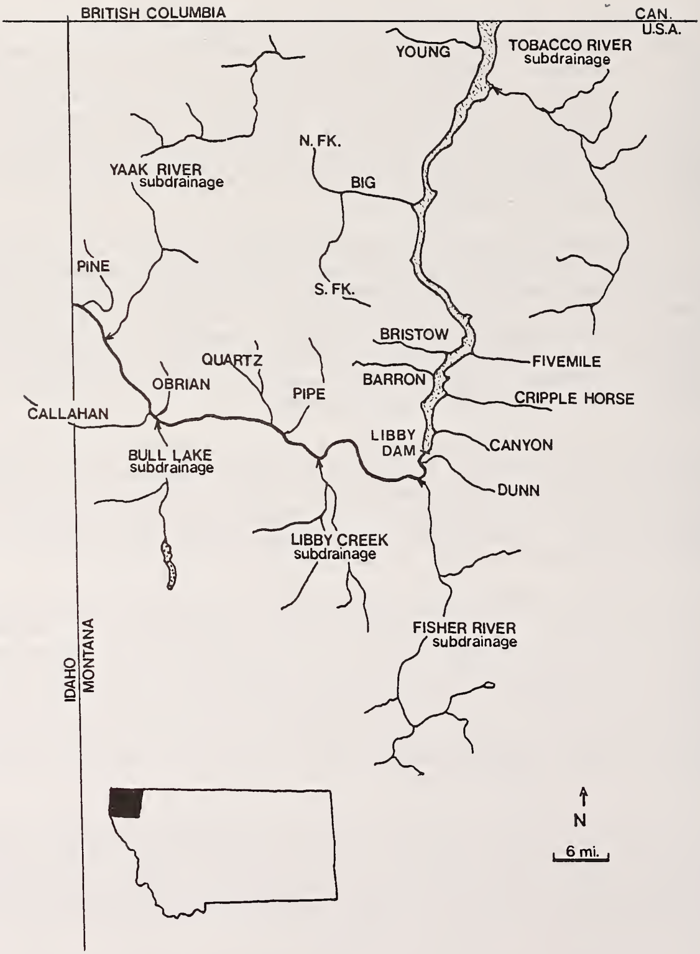

Figure 1. Relative location of study tributaries to Libby Reservoir and the Kootenai River.

Dam. Approximately 80 percent of the drainage is privately owned. The low gradient topography in the basin is utilized extensively for cattle ranching. The five streams included in this report (Pleasant Valley, McGinnis, Silver Butte, East Fisher and West Fisher creeks) show evidence of increased bank erosion from cattle grazing in the riparian areas. All of these tributaries have potential to supply recruits to the Kootenai River.

The Libby Creek subdrainage is the second major tributary to the Kootenai River below Libby Dam. Granite and Big Cherry creeks are high discharge streams flowing from the Cabinet mountains. Swamp and Midas creeks are low discharge streams draining opposite sides of Horse Mountain.

The Bull Lake subdrainage, the third major Kootenai River tributary, is isolated from use by Kootenai River migrant fish by a dam located near its mouth. Outflow from Bull Lake and Keeler Creek converge in Lake Creek which flows north toward the Kootenai River.

The Yaak River subdrainage is the fourth and last major tributary to the Montana portion of the Kootenai River below Libby Reservoir. Yaak Falls, located 13 km upstream from the mouth, presents a barrier to migrant fish from the Kootenai River. The main stem Yaak and its principal forks have received the most interest in the Kootenai drainage for small scale hydroelectric development.

The Kootenai tributaries are characteristically high gradient mountain streams with bed material consisting of various mixtures of sand, gravel, rubble, boulders and differing amounts of clay and silt, predominantly of glacio-lacustrine origin. Fine materials, due to their instability during periods of high stream discharge, are continually abraded and redeposited as gravel bars, forming braided channels with alternating riffles and pools.

Siltation and dewatering are major threats to the aquatic habitat in the tributaries. Siltation has been increased by timber harvest, mining, poor agricultural practices, and road construction. A high percentage of fine material in the streambed, unless removed from the gravels by dominant discharge flows, can be deleterious to the spawning habitat, and egg and fry survival (Peters 1962).

Stream flow in unregulated tributaries generally peaks in May and June after the onset of snow melt, then declines to low flows from November through March. Natural low flows during autumn and winter months combined with surface, anchor and frazil ice, as well as channel scouring during ice-out in spring, can be especially damaging to fish and fish habitat. For this reason, water withdrawals during this time may have an additional impact on the already stressed fish populations. Decreasing flows during summer increase water temperature and reduce the amount of cover

available to rearing young. Extremely low flows may strand adults and young recruits in rapidly warming pools. Therefore, if trout populations are to be maintained at present levels, new consumptive water users (having later priority dates than these future water reservations) must cease withdrawing water when flows fall below the recommended minimums. Senior water users should also be encouraged to conserve water during low water periods to avoid dewatering fishery habitat.

METHODS

Instream Flow Recommendations

The wetted perimeter method described by Nelson (1980) was used to determine instream flows needed to maintain existing fish populations. The upper inflection point in Montana's wetted perimeter method identifies the flow at which nearly all available riffle habitat is wetted (Leathe and Nelson 1986). Flows required for adequate passage for spawning migrants were derived using WETP output. Details of the procedures are explained in Marotz and Fraley (1986). Flow measurements were made using the methods explained by Buchanan and Somers (1969).

Hydrologic Characteristics

For ungauged streams, mean annual discharge was estimated from a multiple regression equation derived by Parrett and Hull (1985). The following log-linear form, based on 47 stream-flow measuring sites and gauging stations in northwest Montana, has an r value of 0.944 and a standard error of 33 percent ($p \geq 0.95$):

$$Q_A = 0.0165\ A^{0.974}\ P^{1.159}$$

Where: Q_A = mean annual discharge (cfs)

A = drainage area (mi^2)

and P = mean annual precipitation

(from U.S. Soil Conservation Service 1977)

Tributary drainage areas were determined using standard USGS topographic maps (2.64 in = 1 mi scale) and an electronic planimeter. The precipitation portion of the equation (P) was based on average annual precipitation from 1941 through 1970 in each watershed (U.S. Soil Conservation Service, 1977). Mean annual discharge and eightieth percentile exceedance flow hydrographs were developed for all gauged streams based on a minimum of ten years of daily readings compiled by the USGS Water Resources Division, Helena, Montana.

Population Estimates

Fish population estimates were conducted from July 1 through October 10 to avoid spring spawning _Salmo_ spp. so as to target resident and pre-emigrant fish. The timing of the estimate reduces the chance of violating the assumption of a closed population and produces results more comparable from year to year. Electrofishing reaches were located in the reach chosen for the wetted perimeter analysis. An attempt was made to choose a sample section that best represented the average stream conditions in the reach for an accurate estimate when results were

extrapolated to number per kilometer and acre. Species composition was based on morphometric characteristics (Scott and Crossman 1973). Rainbow and westslope cutthroat trout were combined for estimates of population size.

A three-person crew (two netters, one shocker) used a Coffelt BP-1C gas-powered backpack electrofishing unit on streams less than 6 cfs. On streams greater than 6 cfs, a bank shocking unit or a drift shocking boat containing a Coffelt variable voltage pulsator-3E electroshocker energized by a Homelite gas-powered generator were used.

The mark-recapture method (Seber 1973) was utilized on four streams in the study. In these streams, endpoints of sample sections were chosen for their location between physical stream features thought to discourage fish passage. Individual fish were marked with a pelvic or caudal fin clip and released throughout the sample section and allowed to redistribute.

Population size ($\hat{N}$) and variance ($\hat{V}[\hat{N}]$) for mark-recapture estimates were calculated according to Seber (1973).

$$\hat{N} = \frac{(M+1)\ (C+1)}{(R+1)} - 1$$

$$\hat{V}[\hat{N}] = \frac{(M+1)\ (C+1)\ (M-R)\ (C-R)}{(R+1)^2\ (R+2)}$$

Where: M = number of marked fish

C = number of fish in the recapture sample

and R = number of marked fish recaptured.

The removal method of population estimation was utilized on 23 streams in the study. On 17 of those streams, acceptable precision was achieved after two removal passes, based on the probability of capture exceeding 50 percent. See Marotz and Fraley (1986) for calculations of ($\hat{N}$) and $\hat{V}(\hat{N})$. On six streams, low probabilities of capture necessitated a third removal pass. Calculation of the population estimate after three removal passes is an involved procedure, and was taken from Armour et al. (1983). The estimated population size ($\hat{N}$) and standard error se(N) were calculated as follows:

$$\hat{N} = \frac{M}{1 - (1 - \hat{p})^3}$$

$$se(N) = \sqrt{\frac{\hat{N}(\hat{N} - M)M}{M^2 - [\hat{N}(\hat{N} - M)(3\hat{p})^2 / (1 - \hat{p})]}}$$

where M = the sum of all removals

$$\hat{p} = 0.996784 - 0.924031(R) + 0.319563(R)^2$$

$$R = (C - M) / M$$

$$C = U_1 + 2U_2 + 3U_3$$

and U = the number of fish in each removal pass (U_1, U_2 and U_3).

Migrant Trapping

Two bi-directional fish traps were installed approximately 1 km upstream from the mouth of Dunn, Seventeenmile, and Quartz creeks to capture migrants traveling both up and downstream. Individual traps were 122 by 122 by 70 cm welded metal frames surrounded on all sides and bottom with 12 mm hardware cloth mesh. An X-shaped arrangement of poultry-mesh leads with 2.54 cm openings, supported by metal fence posts driven into the streambed, guided fish toward the throat of the traps. Escape was made difficult by a V-shaped baffle extending inward at the front of the trap to a 5.8 cm-wide, vertical slot (10 cm-wide for bull trout) in the interior. A trap door in the wooden top and minimal internal reinforcement provided easy access to the catch with a dip net. A water scope was used to assure that all fish were removed from the traps. The trap leads were designed to release if water and debris strained the trap structure (Figure 2). Leads were brushed free of debris up to twice daily and checked with the water scope to maintain trapping efficiency during spring runoff.

Catches were standardized to catch-per-day assuming catch rate was constant. Stream discharge was recorded in conjunction with fish catch. Each captured fish was measured and marked by a clip of the right pelvic fin before release. The largest rainbows and all the bull trout were tagged.

The migrant populations were approximated to the maximum likelihood estimate using Schnabel's multiple census formula modified by Chapman (Ricker 1975):

$$N = \sum \frac{(C_t\ M_t)}{R+1}$$

Where: M_t = the number of marked fish $\geq$ 180 mm at large at time t,

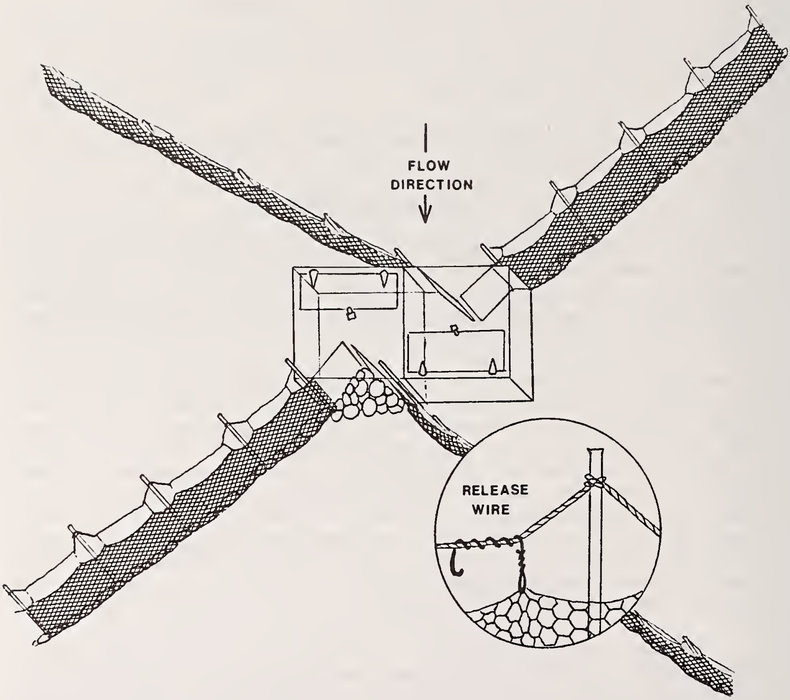

Figure 2. A diagram of the bidirectional fish trapping structure installed in Dunn, Seventeenmile and Quartz creeks. Release wires were designed to drop the trap leads if water and debris strained the trap structure.

C_t = the number of fish $\geq$ 180 mm captured at time t,

and R = the number of marked recaptures.

Approximate limits of confidence ($p \geq 0.95$) for this formula were obtained by considering $\sum R$ as a Poisson variable (Ricker 1977).

The migrant bull trout population was estimated by the mark-recapture method. Migrants were captured on their upstream migration, fin-clipped, tagged and released upstream. Population size ($\hat{N}$) and variance ($\hat{V}[\hat{N}]$) were calculated according to Seber (1973).

$$\hat{N} = \frac{(M+1)\ (C+1)}{(R+1)} - 1$$

$$\hat{V}[\hat{N}] = \frac{(M+1)\ (C+1)\ (M-R)\ (C-R)}{(R+1)^2\ \ (R+2)}$$

Where M = the number of inmigrants captured

C = the number of outmigrants captured

R = the number of marked outmigrants.

Spawning Surveys

Redds were recorded by project personnel in Quartz Creek in October after the spawning run of bull trout was completed. Redds were identified as definite, probable or possible using criteria described by Shepard et al. (1982). Only those redds classified as "definite" or "probable" were included in the final count.

Monitoring Delta Formation

A 75-cm iron stake (fluorescent orange) was driven into the northwest boundary of the Quartz Creek delta. This permanent plumb bob point is on the downriver side of Quartz Creek, and just outside a horse pasture fence. Nails driven into two Cottonwood trees on the upriver side of Quartz Creek serve as bench marks, and are identified with metal tags numbered BM241 and BM242 (see map, Appendix A1). The transit was directed toward BM241, and the angle disk was set to zero degrees. Distance and elevation measurements were made on angles of 0, 35, 50, 55, 60, 70, 82 and 110 degrees. Horizontal distances were measured along a surveyor's tape attached to the plumb bob stake and stretched along the bearing being shot. Elevational (stadia rod) readings were taken along the surveyor's tape at increments determined by changes in topography.

All measurements taken are recorded in Appendix A2-A9. "Horizontal distance" refers to the distance along the surveyor's tape from the fixed stake under the plumb bob. "Stadia rod reading" is that reading off the stadia rod as seen through the transit. "Elevation" refers to the elevation of the delta surface relative to the bench mark. It is arrived at by adding 100 to the reading of BM241 and subtracting the stadia rod reading. Elevations are fixed by the bench mark and are, therefore, directly comparable to future elevations corrected to the same bench mark. Topographic measurements should be reproducible if there has been no surface change on the delta. Plots of each transect are given in Appendix A10-A17, and are generated by inputting elevations along the Y-axis and horizontal distance along the X-axis.

Mid-channel elevations were measured along the primary distributary of Quartz Creek. A tape placed in the deepest part of the stream from the delta surface to the Kootenai River was used to record horizontal distance.

RESULTS AND DISCUSSION

Stream descriptions, population estimates and hydrologic information required for recommending instream flows are presented in seven groups: 1) major forks within the Tobacco River subdrainage, 2) drainages that flow directly into Libby Reservoir, 3) streams that flow directly into the Kootenai River, 4) major tributaries to the Fisher River subdrainage, 5) the Libby Creek subdrainage, 6) the Bull Lake subdrainage, and 7) major stream courses within the Yaak River drainage. Portions of the above groups were previously addressed in Marotz and Fraley (1986).

In many of the streams, the upper inflection point occurs at a higher discharge than is typically observed during the low flow portion of some water years. The upper inflection point represents the optimal flow whereby the full potential of a particular channel morphology to produce fish and prey items is realized. Snowpack and precipitation producing water yield during the study was below normal. In many of the study streams, natural flow conditions are such that the potential for maximum fish production may be limited at times, even without the effects of consumptive water uses.

There are several reasons these streams may historically exhibit this condition. Many of the tributaries included in this study are lower stream order than those of previous studies in Montana. Smaller drainages are more subject to peak flow events than larger basins due to the localized nature of meteorological events. Rarely will all the tributaries of a higher order stream receive a storm of equal intensity. For example, Dunne and Leopold (1978) state that in a Wyoming spring snowmelt area, bankfull discharge is 40 times the mean annual for small basins and ten times for large basins. Rain-on-snow events, which are common in the Kootenai basin, may accentuate this disparity. The resulting channel morphology is shallow and wide, especially when elevated sediment loads are introduced with the peak flows, and the relationship between channel shape and basal flow diminishes. In streams of this type, when discharge declines to basal flow, any withdrawals of stream flow will aggravate pre-existing limitations. It is therefore extremely important that no water be diverted from these streams when flows decline below the recommended limits.

Tobacco River Subdrainage

The Tobacco River is the largest tributary system to Libby Reservoir south of the Canadian border (Figure 3). Results of the wetted perimeter analysis conducted in the lower reaches of the Tobacco River and three inflowing tributaries (Deep, Grave, and Fortine creeks) were previously reported. The four streams included here also support the fishery in the Tobacco River and Libby Reservoir through recruitment of the progeny of migrant fish which ascend the tributaries to spawn. Inflowing waters supply nutrients and food items such as benthic drift and forage fish.

SINCLAIR CREEK

Description

Stream reach: Sinclair Creek from its confluence with the Tobacco River (Sec. 14, T36N, R27W) to its source (Sec. 30, T37N, R25W) (Figure 3).

Stream length: 15.9 km. Total drainage area: 66.2 km^2. Gradient: 35 m per km.

Source and Land Use

Sinclair Creek originates on the western slopes of the Whitefish Mountain range. The highest point in the drainage is Ksanka Peak at 2,288 m (7,505 ft) elevation; and Sinclair Creek joins the Tobacco River at 768 m (2,520 ft) elevation. Approximately 55 percent of the drainage, all in the lower half, is owned by private individuals. Champion International Corporation and the State of Montana together own five percent; the remaining 40 percent of the drainage is held by the U.S. Forest Service.

Timber production, grazing, forage production, and to a lesser extent residential development are the primary land uses in the drainage.

Flows

Few flow data have been obtained on Sinclair Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 19.6 cfs.

Potential Environmental Problems

Water appropriations for Sinclair Creek total 55.2 cfs. If all water users exercised their water rights to the fullest

Figure 3. The Tobacco River subdrainage.

extent, the stream would be dewatered for most of the year. It is unknown what number of claims are valid or presently in use.

Timber harvest, roads, and livestock use of the riparian zone have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on July 23, by a two-pass application of the removal method using backpack electroshocking gear. A 274-m section was sampled (SW 1/4 Sec. 24, T36N, R26W) that had an average width of 4.4 m, and a discharge of 9.6 cfs at the time of sampling. Game fish were primarily *Salmo* spp. (63 percent RB, 20 percent WCT and 17 percent HYB). Electrophoretic analysis of *Salmo* spp. sampled approximately 3 km upstream revealed that genotypic proportions were 86 percent WCT and 13 percent RB. Fish sampled from the northern portion of Libby Reservoir showed a much greater (95 percent) percentage of alleles characteristic of rainbow trout (Leary et al. 1988) which could explain the gradation of species composition in Sinclair Creek. Eastern brook trout were also present in the stream but less abundant than *Salmo* spp. (Table 1). See Appendix B1 and B2 for length-frequency histograms of all fish captured.

Flow Recommendations

Five permanent transects were established in riffle areas in Sinclair Creek 0.2 km downstream from Highway 93 crossing (SW 1/4, Sec. 24, T36N, R26W). The WETP program was calibrated to stage and discharge measurements at flows of 31.6, 10.8 and 1.2 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 2.8 and 6 cfs, respectively (Figure 4). Based on existing fish populations and results of the wetted perimeter analysis, a flow of 6 cfs is recommended for the low flow period from July 16 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 24 cfs (Table 2). A passage flow of 24 cfs is therefore recommended from April 1 through July 15 to ensure successful migration of fish during the spring spawning run.

Table 1. The results of a two-pass population evaluation of fish ≥75 mm in Sinclair Creek (SW 1/4, Sec. 24, T36N, R26W) during July 1987. Discharge 9.6 cfs.

	Salmo spp.	EBT
Fish captured in sample section	143	60
Fish estimated in sample section	147 ± 6	80 ± 13
Fish estimated per kilometer	544 ± 22	296 ± 48
Fish estimated per acre	490 ± 73	267 ± 43
Average length of fish captured (mm)	128	177

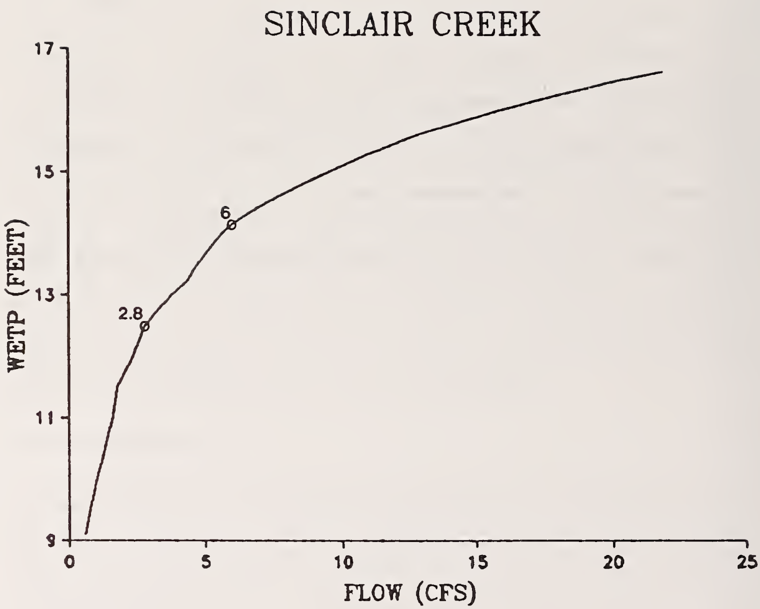

Figure 4. The wetted perimeter-discharge relationship for five riffle transects on Sinclair Creek, 1987.

Table 2. The average depths in five riffle cross sections on Sinclair Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
2.8	.41	.30	.27	.17	.28
6.0	.45	.36	.39	.27	.38
24.0	.67	.57	.71	.50	.64

THERRIAULT CREEK

Description

Stream reach: Therriault Creek from its confluence with the Tobacco River (Sec. 32, T36N, R26W) to its source (Sec. 6, T36N, R26W) (Figure 3).

Stream length: 16.3 km. Total drainage area: 55.9 km^2. Gradient: 28 m per km.

Source and Land Use

Therriault Creek originates on the western slopes of the Whitefish Mountains at Therriault Pass. The highest point in the drainage is an unnamed peak, elevation 2,202 m (7,224 ft). Four third-order tributaries enter the stream before its confluence with the Tobacco River at 732 m (2,400 ft) elevation.

Approximately 47 percent of the drainage, mostly in the lower half, is owned by private individuals. The State of Montana holds four percent and the remainder is held by the U.S. Forest Service. Timber, hay production, and livestock grazing are the primary land uses in the drainage.

Flows

Few flow data have been collected on Therriault Creek except for sporadic measurements by personnel of the Kootenai National Forest and the Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 18.15 cfs.

Potential Environmental Problems

Water appropriations listed for Therriault Creek total 206 cfs (MDNRC 1987). If all water users exercised their water rights to the fullest extent the stream would become dewatered. It is unknown, however, what percentage of existing claims are valid or presently in use.

A point source of sediment pollution exists on Therriault Creek Road (NE 1/4, Sec. 3, T35N, R26W) due to improper road drainage and fill-slope construction in the stream channel. Timber harvest in the drainage, roads, and livestock grazing in the riparian area have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on July 22 by a two-pass application of the removal method using backpack shocking equipment. A 145-m section was sampled (NW 1/4, Sec. 3, T35N, R26W). Average stream width in the sampled section was four m and discharge was 8.5 cfs at the time of sampling.

Game fish population was composed primarily of eastern brook trout, followed in abundance by rainbow trout. One bull trout was also captured. Probability of capture of eastern brook trout was insufficient ($p<0.5$) for a reliable estimate, therefore, minimum estimates only are presented (Table 3). See Appendix B3 and B4 for the length distributions of all fish captured.

Flow Recommendations

Five permanent transects were established on riffle areas in Therriault Creek located approximately 0.5 km upstream of the Highway 93 bridge (NE 1/4, Sec. 3, T35N, R26W). The WETP program was calibrated to stage and discharge measurements at flows of 16.2, 11.3 and 2.6 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 2.5 and 4 cfs, respectively (Figure 5). Based on an evaluation of the existing fishery, results of the wetted perimeter analysis, and estimated water availability, a minimum discharge of 4 cfs is recommended for the low flow period from July 1 through March 31.

An average depth of 0.5 ft, minimum requirement for successful passage of migrant fish, is not reached in all transects until the flow equals or exceeds 7.5 cfs (Table 4). A flow of 7.5 cfs is therefore recommended for the period from April 1 through June 30 to ensure migrant passage and protect spawning redds from dewatering.

Table 3. The results of a two-pass population evaluation of rainbow and eastern brook trout $\geq$75 mm in Therriault Creek (NW 1/4, Sec. 3, T35N, R26W) during July 1987. Discharge 8.5 cfs.

	EBT	RB
Fish captured in sample section	47	23
Fish estimated in sample section	47	26 $\pm$ 8
Fish estimated per kilometer	313	173 $\pm$ 53
Fish estimated per acre	336	186 $\pm$ 57
Average length of fish captured (mm)	127	102

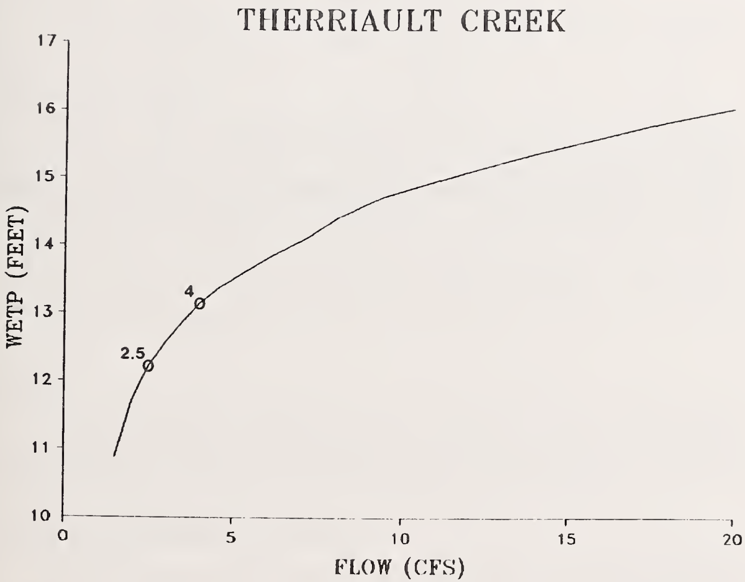

Figure 5. The wetted perimeter-discharge relationship for five riffle transects on Therriault Creek, 1987.

Table 4. The average depths in five riffle cross sections on Therriault Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
2.5	.28	.34	.36	.24	.48
4.0	.36	.42	.43	.36	.55
7.5	.50	.54	.58	.58	.68

EDNA CREEK

Description

Stream reach: Edna Creek from its confluence with Fortine Creek (Sec. 2, T33N, R26W) to the source (Sec. 3, T33N, R27W) (Figure 3).

Stream length: 15 km. Total drainage area: 60 km^2. Gradient: 27 m per km.

Source and Land Use

Edna Creek originates on the east slopes of the Salish Mountains on the north side of Pinkham Mountain, the highest point in the drainage at 1,925 m (6,322 ft) elevation. One third-order tributary enters the stream before its confluence with Fortine Creek at 981 m (3,220 ft) elevation. Private individuals own approximately 38 percent of the watershed, all in the lower two-thirds of the drainage. The State of Montana holds one section and the remainder is held by the U.S. Forest Service. Land use in the drainage is primarily livestock grazing, forage production, and timber production.

Flows

Few discharge records have been obtained on Edna Creek except for sporadic data measurements by personnel of the Montana Department of Fish, Wildlife and Parks and the Kootenai National Forest. Estimated mean annual discharge is 15.7 cfs.

Potential Environmental Problems

Observations indicate that the lower eight km of Edna Creek is poorly suited for spawning due to sparse riffle development and heavy accumulations of sediment in the channel. However, an abundance of beaver dams, especially near the mouth makes pool development excellent in this reach. Beaver pool habitat is typically well-suited for rearing of young fish, but may impede migratory fish passage. Limited but suitable spawning habitat exists in the upper stream reaches making the lower eight km a necessary corridor for migrant fish. Maintenance of existing high flows during the spring, through water reservations, is critical to allow the passage of migrant fish at beaver dams.

Timber harvest, roads and cattle grazing in the riparian area have the potential to increase sediment loading which could potentially degrade the limited spawning habitat.

Fish Populations

A cursory population evaluation was made on October 2 using backpack electroshocking equipment. The sampled section was 50 m

in length and located approximately 0.2 km above the mouth (SE 1/4, Sec. 2, T33N, R26W). Average channel width was 4.3 m and discharge 2.8 cfs at the time of sampling. No population estimate was made. Results of the evaluation indicate a game fish population of approximately equal numbers of young-of-the-year rainbow trout averaging 68 mm in length and adult eastern brook trout averaging 124 mm in length.

Flow Recommendations

The wetted perimeter method could not be used to derive flow recommendations for the lower reach of Edna Creek due to an absence of suitable riffle areas. Flow recommendations were therefore derived from a best estimate based on three measured flows that approximate the seasonal water availability. It should be noted, however, that flow measurements were taken during a relatively dry year and represent conservative approximations of seasonal water availability. Flow measurements and the dates taken are as follows:

23.3 cfs	05-08-87
7.1 cfs	06-10-87
2.8 cfs	10-02-87

Considering measured water availability and observed fish populations, a flow of 3.0 cfs is recommended from July 1 through March 31 to maintain base flows and preserve existing habitat conditions in the stream.

A flow of 22 cfs is recommended for the period from April 1 through June 30. Maintenance of this minimum flow will approximate existing spring runoff conditions for channel maintenance and facilitate migrant fish passage at beaver dams in the lower reach.

SWAMP CREEK (FORTINE)

Description

Stream reach: Swamp Creek from its confluence with Fortine Creek (Sec. 21, T33N, R26W) to its source (Sec. 31, T33N, R28W) (Figure 3).

Stream length: 17.4 km. Total drainage area: 14.4 km^2. Gradient: 15.5 m per km.

Source and Land Use

Swamp Creek originates on the eastern slopes of the Salish Mountains. Pinkham Mountain, elevation 1,925 m (6,322 ft), is the highest point in the drainage. Six third-order tributaries enter the stream between its headwaters at 1,353 m (4,440 ft) and its confluence with Fortine Creek at 1,048 m (3,440 ft) elevation. Private individuals own approximately eight percent of the drainage area with the remaining acreage held by the U.S. Forest Service. Timber production, and to a lesser degree, grazing and residential development are the primary land uses in the drainage.

Flows

Few flow records are available pertaining to Swamp Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 25.6 cfs.

Potential Environmental Problems

Fish habitat in Swamp Creek can be limited during portions of some years by the natural occurrence of extreme low flows. It is essential that the natural basal flow be maintained to prevent total dewatering of the stream during the low flow period of the year.

Cattle grazing in stream riparian zones may cause bank degradation. Timber harvest and roads in the drainage have the potential to increase sediment loading and magnify peak flow events, which may degrade both channel stability and fish habitat.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on September 10, by a two-pass application of the removal method using backpack electroshocking equipment. A 152-m electrofishing reach was selected (SE 1/4, Sec. 21, T33N, R26W) that had an average width of 5.0 m, and a discharge of 1.0 cfs at the time of sampling. Game fish captured were primarily rainbow trout and fewer

numbers of eastern brook trout. The number of brook trout captured was insufficient to make a valid population estimate (Table 5). See Appendix B5 for lengths of all fish captured.

Flow Recommendations

Five permanent transects were established in riffle areas in Swamp Creek, 0.8 km upstream from the mouth (SW 1/4, Sec. 21, T33N, R26W). The WETP program was calibrated to stage and discharge measurements at flows of 48.5, 7.3 and 1.0 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 4 and 10 cfs, respectively (Figure 6). Based on existing fish populations, results of the wetted perimeter analysis, and estimated water availability, a flow of 10 cfs is recommended for the low flow period from July 1 to March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 25 cfs (Table 6). A passage flow of 25 cfs is therefore recommended for the period from April 1 through June 30 to ensure migrant passage and protect spawning redds from dewatering.

Table 5. The results of a two-pass population evaluation of rainbow trout ≥ 75 mm in Swamp Creek (Fortine) (SE 1/4, Sec. 21, T33N, R26W) during September 1987. Discharge 1.0 cfs.

	RB
Fish captured in sample section	75
Fish estimated in sample section	91 $\pm$ 21
Fish estimated per kilometer	607 $\pm$ 140
Fish estimated per acre	483 $\pm$ 112
Average length of fish captured (mm)	113

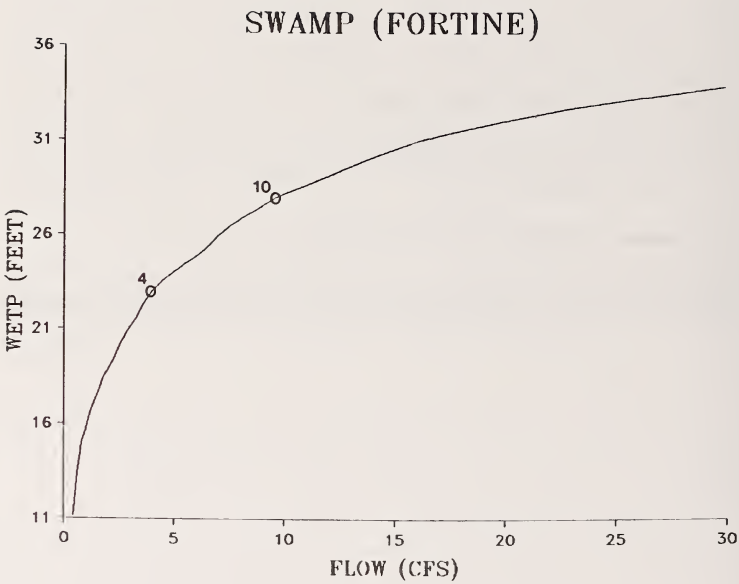

Figure 6. The wetted perimeter-discharge relationship for five riffle transects on Swamp Creek (Fortine), 1987.

Table 6. The average depths in five riffle cross sections on Swamp Creek (Fortine) at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
4	.50	.30	.43	.42	.39
10	.62	.38	.52	.57	.55
25	.74	.50	.70	.80	.77

Libby Reservoir Tributaries

The main stem of Big Creek, Barron, Bristow, Fivemile, and Pinkham creeks were previously analyzed. The North and South forks of Big Creek, Cripple Horse and Canyon creeks reported here, complete the analysis of the most important streams in Montana which supply recruitment of young trout to Libby Reservoir (Figure 7).

NORTH FORK BIG CREEK

Description

Stream reach: North Fork Big Creek from its junction with South Fork Big Creek (Sec. 28, T35N, R30W) to the source (Sec. 6, T35N, R30W) (Figure 7).

Stream length: 12.6 km. Total drainage area: 47.4 km^2. Gradient: 65 m per km.

Source and Land Use

North Fork Big Creek originates on the east slopes of the Purcell Mountains. The highest point in the drainage is Lost Horse Mountain at 1,999 m (6,558 ft) elevation. Two second-order named tributaries enter the stream before its confluence with the South Fork at 949 m (3,114 ft) elevation. The U.S. Forest Service is the sole landholder in the drainage. Timber production and recreation are the primary land uses.

Flows

Few discharge records have been compiled pertaining to North Fork Big Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 13.8 cfs.

Potential Environmental Problems

Portions of Big Creek have been targeted for small scale hydroelectric development. Although initial applications were later withdrawn, interest in future development is anticipated as surplus power in the region decreases and construction of additional facilities becomes feasible.

Timber harvest and roads in the drainage have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat. A rock barrier waterfall located approximately 0.8 km from the mouth (SW 1/4, Sec. 28, T35N, R30W) limits the amount of spawning habitat in the stream that is available to migrants from Libby Reservoir. It is

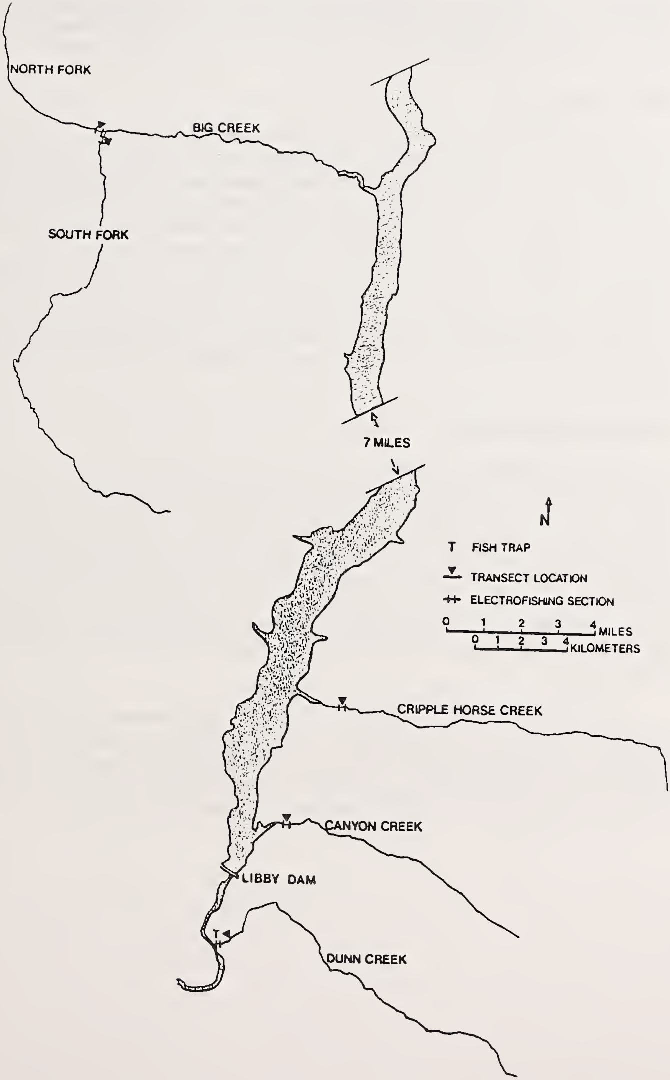

Figure 7. The Libby Reservoir tributaries and location of Dunn Creek downstream from Libby Dam.

therefore especially important that environmental impacts be avoided to maintain existing recruitment to Libby Reservoir from North Fork Big Creek.

Fish Populations

A population estimate was obtained on July 28 by a two-pass application of the removal method using backpack electrofishing equipment. The 198-m sampling reach was located approximately 0.3 km upstream from the mouth, directly above Forest Road 336 bridge (SW 1/4, Sec. 28, T35N, R30W). Average channel width was 5.9 m and discharge at the time of sampling was 5.1 cfs. Game fish species composition was 60 percent WCT, 37 percent RB, and 3 percent HYB; one mountain whitefish was also captured. Probability of capture for Salmo spp. was too low ($p<0.5$) to make a precise population estimate, therefore only minimum estimates are provided (Table 7). See Appendix B6 for lengths of all fish captured.

Flow Recommendations

Five permanent transects were established in riffle areas in North Fork Big Creek 0.5 km from the mouth (SE 1/4, Sec. 28, T35N, R30W). The WETP program was calibrated to stage and discharge measurements at flows of 68.4, 10.0 and 5.1 cfs. Inflection points in a plot of the wetted perimeter-discharge relationship occur at 7 and 14 cfs, respectively (Figure 8). Based on existing fish populations, results of the wetted perimeter analysis, and estimated water availability, a flow of 14 cfs is recommended for the low flow period from July 16 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 27 cfs (Table 8). A passage flow of 27 cfs is therefore recommended from April 1 through July 15 to ensure successful migration of fish during the spring spawning run.

Table 7. The results of a two-pass population evaluation of *Salmo* spp. $\geq$75 mm in North Fork Big Creek (SW 1/4, Sec. 28, T35N, R30W) during July 1987. Discharge 5.1 cfs.

	Salmo spp.
Fish captured in sample section	35
Fish estimated in sample section	35
Fish estimated per kilometer	175
Fish estimated per acre	120
Average length of fish captured (mm)	117

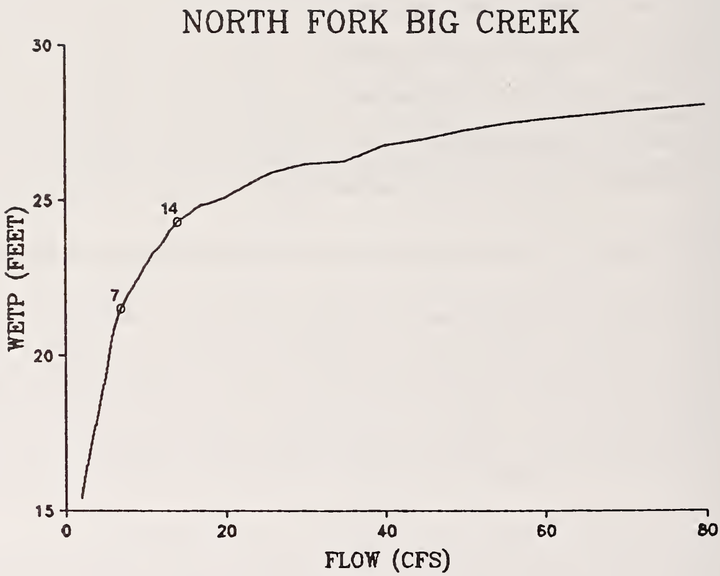

Figure 8. The wetted perimeter-discharge relationship for four riffle transects on North Fork Big Creek, 1987.

Table 8. The average depths in five riffle cross sections on North Fork Big Creek at selected flows of interest.

Flow	Average depth (ft)				
	CS1	CS2	CS3	CS4	CS5
7	.27	.31	.32	.49	.38
14	.40	.38	.44	.61	.53
27	.54	.52	.50	.79	.69

SOUTH FORK BIG CREEK

Description

Stream reach: South Fork Big Creek from its junction with North Fork Big Creek (SW 1/4, Sec. 28, T35N, R30W) to the headwaters (Sec. 27, T33N, R29W) (Figure 7).

Stream length: 343.4 km. Total drainage area: 194 km^2. Gradient: 20.3 m per km.

Source and Land Use

The South Fork of Big Creek originates on the east side of the Purcell Mountains, on the north slope of Lost Soul Mountain and the south slope of Lawrence Mountain. The stream flows in a northerly direction from its headwaters at 1,646 m (5,400 ft) elevation; four third-order tributaries enter the South Fork before its confluence with North Fork Big Creek at 949 m (314 ft) elevation. The entire drainage is held by the U.S. Forest Service. Timber production and recreation are the primary land uses in the drainage.

Flows

Few flow data have been collected on South Fork Big Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 74 cfs.

Potential Environmental Problems

Big Creek has been targeted for small scale hydroelectric development. Although initial applications were later withdrawn, interest in future development is anticipated as surplus power in the region decreases and construction of additional facilities becomes feasible.

Big Creek is a major spawning and rearing tributary for spring migrants from Libby Reservoir. Timber harvest and roads in the drainage have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat, thus reducing recruitment to the reservoir from Big Creek.

Fish Populations

Resident and Pre-emigrant Fish

A population evaluation was obtained on July 27 by a two-pass application of the removal method using backpack shocking equipment. The 185-m electrofishing section was located 0.2 km upstream from the mouth (NE 1/4, Sec. 33, T35N, R30W). Average stream width in the electrofishing reach was 6.8 m and discharge

was 7.7 cfs at the time of sampling. Game fish were primarily *Salmo* spp. (RB 76 percent, WCT 15 percent, HYB 10 percent) (Table 9). One eastern brook trout was also captured. See Appendix B7 for the length-frequency distribution of all fish captured.

The limitations of the shocking equipment in two pools of excessive depth and abundant cover, may have biased the population estimate, thus underestimating populations extrapolated to number per kilometer and acre.

Flow Recommendations

Five permanent transects were established in riffle areas in South Fork Big Creek located approximately 0.2 km above the mouth (NE 1/4, Sec. 33, T35N, R30W). The WETP program was calibrated to stage and discharge measurements at flows of 27.9, 8.7 and 7.7 cfs. Inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 10 and 20 cfs, respectively (Figure 9). Based on evaluation of the existing fishery and results of the wetted perimeter analysis, a discharge of 20 cfs is recommended for the low flow period from July 16 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 22 cfs (Table 10). A flow of 22 cfs is therefore recommended for the period from April 1 through July 15 to ensure migrant passage and protect spawning redds from dewatering.

Table 9. The results of a two-pass population evaluation of *Salmo* spp. ≥75 mm in South Fork Big Creek (NE 1/4, Sec. 33, T35N, R30W) during July 1987. Discharge 7.7 cfs.

	Salmo spp.
Fish captured in sample section	103
Fish estimated in sample section	122 ± 21
Fish estimated per kilometer	678 ± 116
Fish estimated per acre	407 ± 70
Average length of fish captured (mm)	110

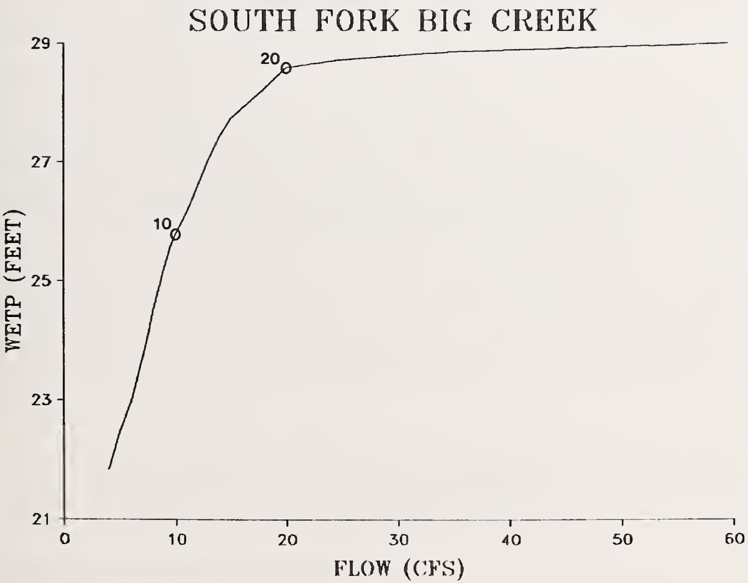

Figure 9. The wetted perimeter-discharge relationship for four riffle transects on South Fork Big Creek, 1987.

Table 10. The average depths in five riffle cross sections on South Fork Big Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
10	.39	.44	.44	.43	.54
20	.54	.56	.48	.54	.68
22	.57	.56	.50	.56	.70

CRIPPLE HORSE CREEK

Description

Stream reach: Cripple Horse Creek from its confluence with Libby Reservoir (SE 1/4, Sec. 2, T31N, R29W) to the headwaters (Sec. 21, T31N, R27W) (Figure 7).

Stream length: 21.1 km. Total drainage area: 91.5 km^2. Gradient: 30.8 m per km.

Source and Land Use

Cripple Horse Creek originates on the west slope of the Salish Mountains. Boundary Mountain at 1,815 m (5,955 ft) elevation is the highest point in the drainage. Seven third-order tributaries enter the stream before its confluence with Libby Reservoir at 756 m (2,480 ft) elevation. Approximately three percent of the watershed, primarily in the lower third, is owned by private individuals and the State of Montana. The remainder of the watershed is held by the U.S. Forest Service. Timber production, and to a lesser degree, grazing and recreation are the primary land uses in the watershed. A private marina and campground operating under a special use permit from the U.S. Forest Service is located at the mouth of Cripple Horse Creek on Libby Reservoir.

Flows

Few flow data have been obtained on Cripple Horse Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 23.2 cfs.

Potential Environmental Problems

Cattle grazing in the riparian zone and timber harvest activity in the Cripple Horse Creek drainage have the potential to increase sediment loading and peak flow events causing channel instability and damage to fish habitat. A point source of moderate sedimentation in the lower reach of stream occurs along Forest Road 835 (Sec. 1 and 6, T31N, R28W).

A rock barrier located approximately 3.5 km from the mouth (SE 1/4, Sec. 6, T31N, R28W) limits the amount of spawning habitat in Cripple Horse Creek available to migrants from Libby Reservoir.

Fish Populations

A population estimate was obtained on July 20 by a two-pass application of the removal method using backpack electroshocking gear (Table 11). A 145-m electrofishing reach (SE 1/4, Sec. 1, T31N, R28W) was selected that had an average width of 3.4 m and a discharge of 1.9 cfs at the time sampling. Game fish in the

sample were predominantly Salmo spp. (52 percent RB, 37 percent WCT, 11 percent HYB) and fewer eastern brook trout. See Appendix B8 for length-frequency histogram for all fish captured.

Observations made upstream of the sampled section, above the barrier, indicate a substantial resident population of fish 50 to 150 mm in length.

Flow Recommendations

Five permanent transects were established in riffle areas in Cripple Horse Creek directly upstream from Forest Road 334 bridge (SW 1/4, Sec. 1, T31N, R29W). The WETP program was calibrated to stage and discharge measurements at flows of 63.2, 5.0 and 1.9 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 4 and 8 cfs respectively (Figure 10). Based on existing fish populations and results of the wetted perimeter analysis, a flow of 8 cfs is recommended for the low flow period from July 16 to March 31.

An average depth of 0.5 ft, minimum depth requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 14 cfs (Table 12). A passage flow of 14 cfs is therefore recommended from April 1 through July 15 to ensure successful migration of fish during the spring spawning run.

Table 11. The results of a two-pass population evaluation of *Salmo* spp. $\geq$75 mm in Cripple Horse Creek (SE 1/4, Sec. 1, T31N, R28W) during July 1987. Discharge 1.9 cfs.

	Salmo spp.
Fish captured in sample section	64
Fish estimated in sample section	75 ± 16
Fish estimated per kilometer	517 ± 110
Fish estimated per acre	625 ± 133
Average length of fish captured (mm)	101

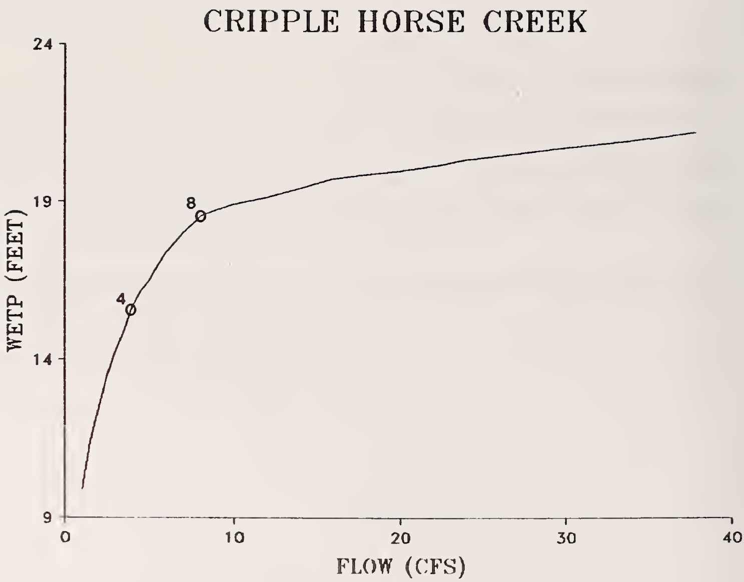

Figure 10. The wetted perimeter-discharge relationship for five riffle transects on Cripple Horse Creek, 1987.

Table 12. The average depths in five riffle cross sections on Cripple Horse Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
4	.35	.32	.42	.25	.40
8	.38	.44	.56	.38	.46
14	.51	.60	.69	.53	.58

CANYON CREEK

Description

Stream reach: Canyon Creek from its confluence with the eastern shore of Libby Reservoir (Sec. 22, T31N, R29W) to the source (Sec. 26, T30N, R28W) (Figure 7).

Stream length: 13.4 km. Total drainage area: 54 km^2. Gradient: 38 m per km.

Source and Land Use

Canyon Creek originates on the western slopes of the Salish Mountains. Boundary Mountain is the highest point in the drainage at 1,815 m (5,955 ft) elevation; one third-order tributary enters before its confluence with Libby Reservoir at an elevation of 756 m (2,480 ft) elevation.

Approximately nine percent of the drainage area is held by the State of Montana and Burlington Northern Railroad, the remaining acreage is held by the U.S. Forest Service. Timber production is the primary land use in the drainage.

Flows

Few discharge records have been obtained on Canyon Creek except for sporadic measurements by personnel of the Montana Department of Fish, Wildlife and Parks and the Kootenai National Forest. Estimated mean annual discharge is 14.4 cfs.

Potential Environmental Problems

Timber harvest and roads in the drainage have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat.

Spawning habitat for Libby Reservoir migrants is limited in Canyon Creek due to a 6 m rock barrier located approximately 1.8 km from the mouth (SE 1/4, Sec. 23, T31N, R29W). Redd surveys by U.S. Forest Service personnel indicate that the reach below the barrier is used as spawning habitat by spring migrants from the reservoir. Nine redds were observed in 1979, 10 in 1982, 7 in 1983, 14 in 1984 and 16 in 1985 (pers. comm. Maggie Craig, USFS).

Maintenance of suitable water quality in the limited area of spawning habitat is essential to maintain current levels of recruitment.

Fish Populations

Resident and Pre-emigrant Fish

Two population estimates were obtained by a two-pass application of the removal method using backpack shocking equipment. Game fish in both samples were composed exclusively of Salmo spp. (44 percent RB, 35 percent WCT, 12 percent HYB).

On July 15 a 244-m section was sampled (SE 1/4, Sec. 22, T31N, R29W) that had an average width of 1.7 m and a discharge of 0.2 cfs. Probability of capture of Salmo spp. in the sample section was insufficient ($p<0.5$) for an accurate population estimate, therefore only minimum estimates are presented (Table 13).

A second population estimate was obtained on October 9. This 67-m sample section was located directly downstream of the July 15 section and averaged 1.0 m in width and had an estimated discharge of 0.1 cfs (Table 13). See Appendix B9 for combined length-frequency histogram of fish captured in both samples.

Flow Recommendations

Five permanent transects were established in riffle areas in Canyon Creek located approximately 0.4 km upstream from the mouth, directly above State Highway 37 (SE 1/4, Sec. 22, T31N, R29W). The WETP program was calibrated to stage and discharge measurements at flows of 13.4, 3.4, 1.5 and 0.2 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 1.6 and 4 cfs respectively (Figure 11). Based on an evaluation of the existing fishery and results of the wetted perimeter analysis, a discharge of 4 cfs is recommended for the low flow period from July 16 through March 31.

An average depth of 0.5 ft, the minimum requirement for successful passage of migrant fish, is not reached in all transects until the flow equals or exceeds 12 cfs (Table 14). A flow of 12 cfs is therefore recommended for the period from April 1 through July 15 to ensure migrant passage and protect spawning redds from dewatering.

Table 13. The results of two two-pass population evaluations of *Salmo* spp. in Canyon Creek (SE 1/4, Sec. 22, T31N, R29W) during July and October 1987. Discharge at the time of sampling was 0.2 and 0.1 cfs, respectively.

	July Estimate	October Estimate	
	Salmo $\geq$ 75 mm	*Salmo* $\geq$ 75 mm	*Salmo* < 75 mm
Fish captured in sample section	55	18	113
Fish estimated in sample section	55	24 $\pm$ 17	128 $\pm$ 16
Fish estimated per kilometer	229	343 $\pm$ 243	1829 $\pm$ 229
Fish estimated per acre	550	1200 $\pm$ 850	6400 $\pm$ 800
Average length of fish captured (mm)	99	104	58

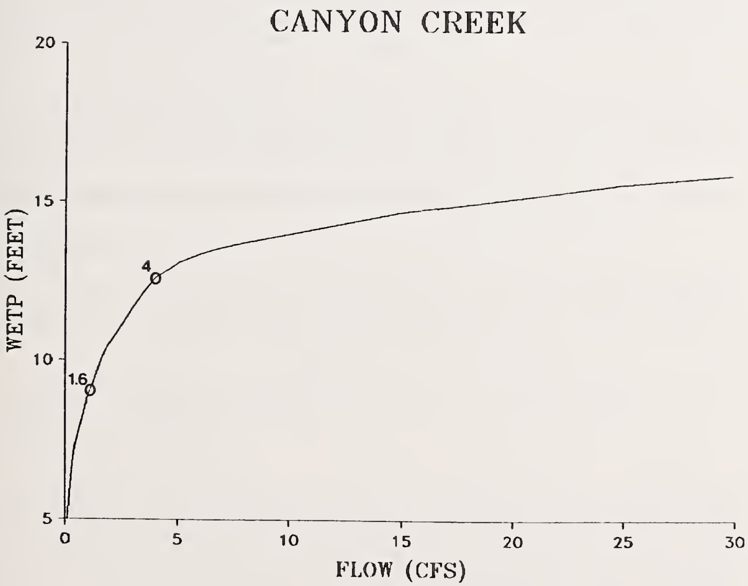

Figure 11. The wetted perimeter-discharge relationship for five riffle transects on Canyon Creek, 1987.

Table 14. The average depths in five riffle cross sections on Canyon Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
1.6	.35	.18	.28	.25	.29
4.0	.46	.31	.32	.34	.35
12.0	.62	.57	.52	.54	.50

Kootenai River Tributaries

Subdrainages in which several applications of the wetted perimeter analysis were completed have been grouped separately within this report. Tributaries treated singularly, including Dunn (Figure 7) and Pine (Figure 30) creeks are reported here. Other Kootenai River tributaries fitting this description (e.g., Bobtail, O'Brien, Pipe and Quartz creeks) were described in May (1982) and Marotz and Fraley (1986).

Natural recruitment of young trout to the Kootenai River has so far been sufficient to maintain the river fishery. It is important that nursery streams be protected to ensure continuing recruitment to the Kootenai River below Libby Dam.

DUNN CREEK

Description

Stream reach: Dunn Creek from its confluence with the east side of the Kootenai River below Libby Dam (Sec. 9, T30N, R29W) to the source (Sec. 26, T26N, R28W) (Figure 7).

Stream length: 21.6 km. Total drainage area: 88 km^2. Gradient: 37.8 m per km.

Source and Land Use

Dunn Creek originates on the western slopes of the Salish Mountains, on the southwest slope of Redemption Ridge. Two named tributaries enter the stream between its headwaters at 1,463 m (4,800 ft) elevation and the mouth at 646 m (2,120 ft) elevation. Approximately 38 percent of the watershed, primarily the mouth and headwaters area, is owned by private corporations or the state. Burlington Northern Railroad is the major private landholder, followed by Champion International Corporation. The State of Montana holds approximately two sections, and the U.S. Corps of Engineers holds a small parcel, at the mouth. Private individuals own approximately 40 acres along the stream 11 km from the mouth. The remainder of the watershed acreage is held by the U.S. Forest Service. Checkerboard ownership patterns exist between Burlington Northern Railroad and the U.S. Forest Service in the headwaters area.

Timber production, and to a minor degree, recreation are the primary land uses in the basin. A day-use camping and fishing access area is located at the mouth of Dunn Creek.

Flows

Few flow records are available pertaining to Dunn Creek except for sporadic measurements by personnel of the Kootenai National

Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 23.5 cfs.

Potential Environmental Problems

The city of Libby has proposed the construction of a run of the river dam to be located approximately 9.5 km below the mouth of Dunn Creek on the Kootenai River. The proposed Jennings Rapids Dam and reservoir if built, would inundate the lower creek area, eliminating excellent spawning habitat. The dam could also impede access to Dunn Creek by river spawners migrating from below the proposed dam site.

Timber harvest and roads in the drainage have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat thus reducing present recruitment to the river from Dunn Creek. Impacts are more likely to be realized due to the difficulties checkerboard ownership imposes on the coordination of land management activities.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on July 16 by a three-pass application of the removal method using backpack electroshocking gear. A 131-m sample section was selected that was located 0.4 km from the mouth (NE 1/4 Sec. 9, T 30N, R29W). Average channel width was 4.26 m and discharge was 2.5 cfs at the time of sampling. Game fish population was composed primarily of rainbow trout (Table 15). One eastern brook trout was also captured. Observations indicate that upstream reaches of Dunn Creek contain habitat more suitable for eastern brook trout and likely support a greater population than was observed in the sample reach. See Appendix B10 and B11 length-frequency histograms for all fish captured.

Migrant Fish

A bidirectional trap structure was installed approximately 0.4 km above the mouth of Dunn Creek (NE 1/4, Sec. 9, T30N, R29W) to capture migrants moving up and downstream. The upstream migrant trap was monitored singularly from April 15, 1987, through May 6, 1987, when the downstream migrant trap became functional. Both traps continued to be monitored through July 24, 1987, when high flows destroyed the trap system.

The first capture of upstream migrants occurred April 17, indicating that the spawning run had already begun. The majority of the upstream migrants entered between April 17 and May 8 with the last capture occurring on June 29. A total of 73 upstream migrant trout were captured. Downstream migrant trapping efforts were largely unsuccessful due to trap avoidance or difficulties in

Table 15. The results of a three-pass population evaluation of rainbow trout ≥ 75 mm in Dunn Creek (NE 1/4, Sec. 9, T30N, R29W) during July 1987. Discharge 2.5 cfs.

	RB
Fish captured in sample section	39
Fish estimated in sample section	41 $\pm$ 20
Fish estimated per kilometer	312 $\pm$ 152
Fish estimated per acre	241 $\pm$ 117
Average length of fish captured (mm)	141

holding fish in the trap. We therefore, collected downstream migrants by dipnetting or electroshocking in the area above the downstream migrant trap. Downstream migrants first appeared on May 11 and continued through July 18. It is possible that some downstream migrants remained unaccounted for as capture efforts were discontinued prematurely due to trap failure. The total number of downstream migrants captured was 50, of which 27 were unmarked indicating that some migrants may have passed upstream before our trapping began.

The maximum likelihood estimate of the total migrant population (Ricker 1975) amounted to 175 Salmo spp. with a range of 125 to 297, Poisson. The length distribution of captures is shown in Appendix B11. Species composition was RB 91 percent, WCT 4 percent, and HYB 5 percent.

A total of seven definite and four probable redds were observed between the trap site and the mouth of Dunn Creek. It is probable that the fish using these redds never entered our trap and were not represented in our migrant estimate. No redd survey was conducted above the trap site.

Flow Recommendations

Five permanent transects were established in riffle areas in Dunn Creek located 0.5 km upstream of the mouth, directly above the U.S. Highway 37 crossing (NE 1/4, Sec. 9, T30N, R29W). The WETP program was calibrated to stage and discharge measurements at flows of 29.5, 17.2, 7.4 and 0.8 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 3 and 8 cfs, respectively (Figure 12). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 8 cfs is recommended for the period from July 16 through March 31.

An average depth of 0.5 ft, the minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 18 cfs (Table 16). Therefore, a flow of 18 cfs is recommended for the period from April 1 through July 15 to ensure successful passage of migrants during the spring spawning run and prevent dewatering of redds.

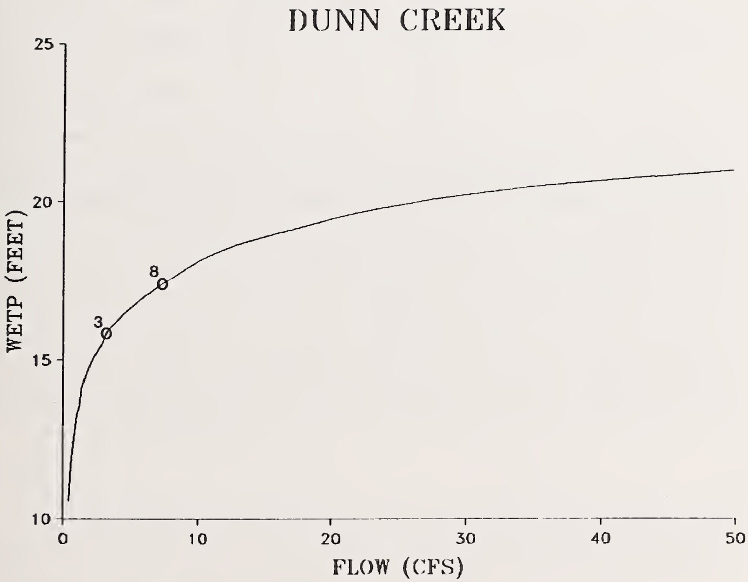

Figure 12. The wetted perimeter-discharge relationship for five riffle transects on Dunn Creek, 1987.

Table 16. The average depths in five riffle cross sections on Dunn Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
3	.26	.32	.42	.37	.35
8	.38	.43	.55	.53	.44
18	.50	.56	.65	.66	.60

PINE CREEK

Description

Stream Reach: Pine Creek from its confluence with the Kootenai River (Sec. 27, T33N, R34W) to its source (Sec. 16, T34N, R34W) (Figure 30).

Stream length: 18.5 km. Total drainage area: 53.6 km^2. Gradient: 17 m per km.

Source and Land Use

Pine Creek originates on the south slope of Cross Mountain; the highest point in the drainage is 2,002 m (6,568 ft) elevation. One third-order tributary enters the stream before its confluence with the Kootenai at 1,182 m (3,880 ft) elevation. Private individuals own approximately seven percent of the drainage, all adjacent to the stream. Champion International Corporation owns one section, and the remainder is held by the U.S. Forest Service. Timber production and livestock grazing are the major land uses in the drainage. A small, privately-owned hydroelectric site is located approximately 13 km from the mouth (Sec. 18, T34N, R34W). An additional small hydroelectric site has also been proposed just downstream of U.S. Highway 2 (SW 1/4, Sec. 27, T33N, R34W). Although a FERC permit has been granted for this project, the present status is unknown.

Flows

Few flow data have been obtained on Pine Creek except for sporadic data measurements by personnel of the Montana Department of Fish, Wildlife and Parks and the Kootenai National Forest. Estimated mean annual discharge is 22.8 cfs.

Potential Environmental Problems

Timber harvest, roads and cattle grazing in the riparian area have the potential to increase sediment loading and magnify peak flow events which may degrade channel stability and fish habitat.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on July 20 by a two-pass application of the removal method using backpack electroshocking equipment. The 153-m sampling section (NE 1/4, Sec. 27, T33N, R34W) had an average width of 3.6 m and a discharge of 4.9 cfs at the time of sampling. Game fish population in the sampled section consisted exclusively of resident eastern brook trout (Table 17). See Appendix B12 for the length distribution of all fish captured.

Table 17. The results of a two-pass population evaluation of eastern brook trout $\geq$75 mm in Pine Creek (NE 1/4, Sec. 27, T33N, R34W) during July 1987. Discharge 4.9 cfs.

	EBT
Fish captured in sample section	36
Fish estimated in sample section	48 $\pm$ 24
Fish estimated per kilometer	320 $\pm$ 160
Fish estimated per acre	343 $\pm$ 171
Average length of fish captured (mm)	165

High gradients (i.e., >20 percent slope) and interspersed 3.0- to 4.5-m cascades in the lower 0.6 km of the stream impose a barrier to fish migrating from the Kootenai River into Pine Creek. Therefore, fish in the study reach were believed to be a self-sustaining, resident population. Although only eastern brook trout were captured during our electrofishing survey, stream habitat conditions were also suitable for *Salmo* spp. which potentially could inhabit other portions of the stream.

Flow Recommendations

Five permanent transects were established on riffle areas in Pine Creek located approximately 1.9 km from the mouth, upstream of the Highway 508 crossing (NE 1/4, Sec. 37, T33N, R34W). The WETP program was calibrated to stage and discharge measurements at flows of 23.8, 9.5, 4.9 and 1.8 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 2.7 and 5.5 cfs, respectively (Figure 13). Based on an evaluation of the existing fishery, and results of the wetted perimeter analysis, a minimum discharge of 5.5 cfs is recommended for the low flow period from July 1 through March 31.

Eastern brook trout spawn during the fall, corresponding with the low flow portion of the year. Natural reproduction should maintain the present population size, provided that environmental conditions remain stable. No water should be removed from the stream when flows decline to 5.5 cfs or below.

If westslope cutthroat trout, a species of special concern in Montana, inhabit Pine Creek or become established there, a spring passage flow should be maintained. An average depth of 0.5 ft, the minimum requirement for passage, is not met in all transects until the flow equals or exceeds 17 cfs (Table 18). A flow of 17 cfs is therefore recommended in Pine Creek for the period from April 1 through June 30 to ensure the successful passage of migrants and to prevent dewatering of redds. A dominant discharge flow (presently undefined) should occur for at least 24 hours during the spring runoff to flush sediments and maintain channel integrity.

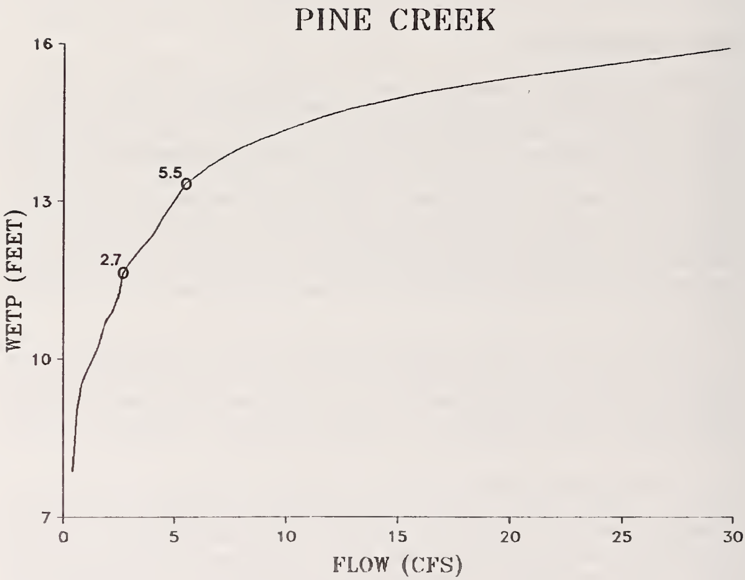

Figure 13. The wetted perimeter-discharge relationship for five riffle transects on Pine Creek, 1987.

Table 18. The average depths in five riffle cross sections on Pine Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
2.7	.30	.34	.25	.29	.35
5.5	.36	.43	.28	.39	.44
17.0	.58	.59	.50	.57	.57

Fisher River Subdrainage

The Fisher River is one of four major spawning tributaries in the Montana portion of the Kootenai River below Libby Dam. The proposed Jennings Rapids Dam, if built, could inundate the lower reach of the Fisher River and would isolate the drainage from spawning migrants downstream of the proposed dam site.

The wetted perimeter method was used to recommend instream flows for the maintenance of fish production in the main stem of the Fisher River and Wolf Creek (Marotz and Fraley 1986). The results of the same analysis conducted in the upstream portion of the Fisher River and its primary tributaries, presented here, further refine the instream flow needs in the drainage (Figure 14).

PLEASANT VALLEY FISHER RIVER

Description

Stream reach: Pleasant Valley Fisher River from its junction with Silver Butte Fisher River (Sec. 9, T26N, R30W), to the outlet of Little Loon Lake (Sec. 27, T27N, R28W) (Figure 14).

Total Stream length: 68.7 km. Total drainage area: 759 km^2. Gradient: 4.6 m per km.

Source and Land Use

Pleasant Valley Fisher River originates on the western slopes of the Salish Mountains. Meadow Peak, elevation 2,043 m (6,702 ft), is the highest point in the drainage. From its headwaters at 1,219 m (4,000 ft), nineteen third- and fourth-order tributaries enter Pleasant Valley Fisher which passes through Loon and Little Loon Lakes before its confluence with Silver Butte Fisher River at 902 m (2,960 ft) elevation.

Approximately 70 percent of the drainage area is privately owned. Champion International Corporation is the major landowner, followed next in acreage by private ownership and Burlington Northern Railroad. The U.S. Forest Service and State of Montana hold the remaining acreage. Timber harvest, forage production and livestock grazing are the primary land uses in the drainage.

Flows

Flow data are limited for Pleasant Valley Fisher River, except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 175.6 cfs.

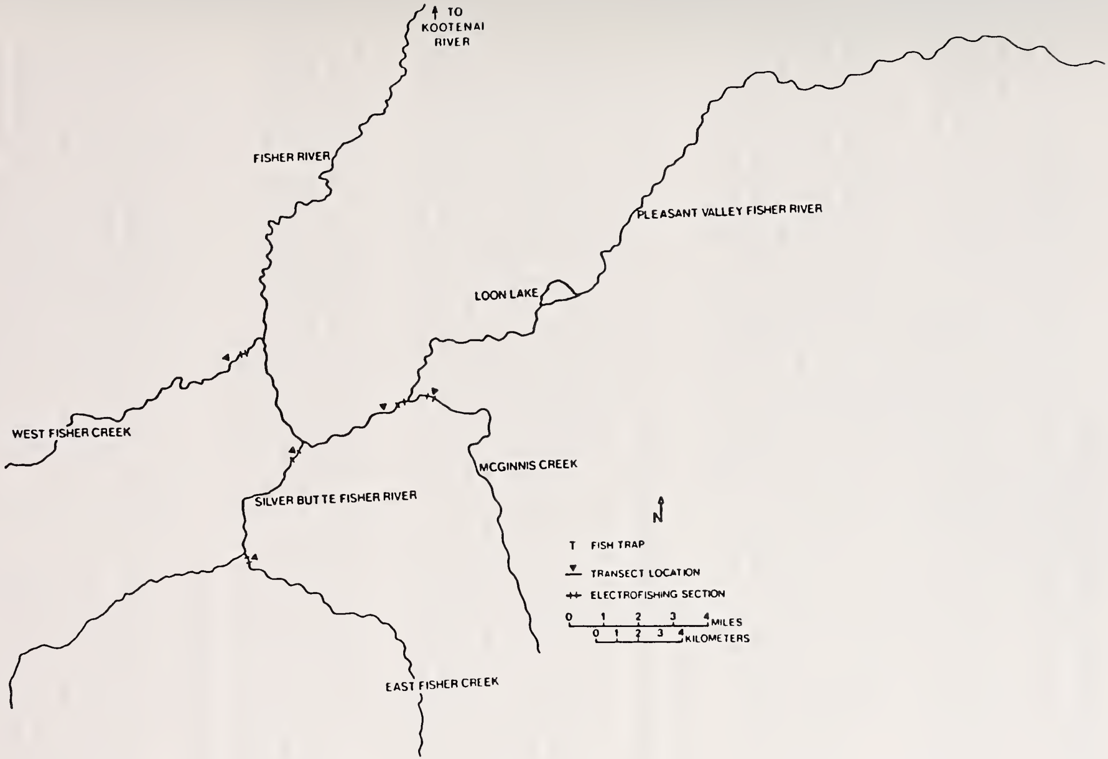

Figure 14. The Fisher River subdrainage.

Potential Environmental Problems

Water appropriations listed for Pleasant Valley Fisher River total 117.1 cfs (MDNRC 1987). This total does not include water allotment for livestock nor water allocations for major tributaries such as Pleasant Valley Creek or McGinnis Creek which are apparently over appropriated. If all water users exercise their water rights to the fullest extent Pleasant Valley Fisher River could potentially become dewatered.

Timber harvest, road construction, livestock grazing, and loss of vegetative cover due to forest fire are extensive in the drainage. Soils adjacent to much of the stream course are moderate to highly erodible. Sediment flushing ability of the stream is limited by low gradient. These factors combined have the potential to cause or increase sediment loading and peak flow events which may degrade channel stability and fisheries habitat.

Fish Populations

Resident and Pre-emigrant Fish

A population evaluation was obtained on August 19, by a two-pass application of the removal method using bank shocking equipment. A 294-m section, located directly downstream of Forest Road 516 bridge, was sampled (NW 1/4, Sec. 1, T26N, R29W). Stream width in the electrofishing section averaged 18 m, and the discharge was 24 cfs at time of sampling. Rainbow trout were the most numerous game fish captured (Table 19), followed in abundance by mountain whitefish. One eastern brook trout was also captured. See Appendix B13 for a length-frequency histogram of all fish captured.

Population statistics projected per kilometer and acre may be underestimated. Populations in the sample reach, may have been artificially reduced by fishing mortality due to easy access near road 516 bridge. The limited effectiveness of the shocking equipment in two excessively deep pools may also have reduced the population estimate in the sample reach.

Flow Recommendations

Five permanent transects were established on riffle areas located approximately 5.5 km upstream from the mouth (SE 1/4, Sec. 2, T26N, R29W). The WETP program was calibrated to stage and discharge measurements at flows of 100.1, 60.3, 42.7 and 23.4 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 15 and 32 cfs respectively (Figure 15). Based on an evaluation of the existing fishery, and results of the wetted perimeter analysis, a minimum discharge of 32 cfs is recommended for the low flow period from July 1 through March 31.

Table 19. The results of a two-pass population evaluation of rainbow trout $\geq$75 mm in Pleasant Valley Fisher River (NW 1/4, Sec. 1, T26N, R29W) during August 1987. Discharge 24 cfs.

	RB
Fish captured in sample section	35
Fish estimated in sample section	44 $\pm$ 18
Fish estimated per kilometer	152 $\pm$ 62
Fish estimated per acre	73 $\pm$ 30
Average length of fish captured (mm)	130

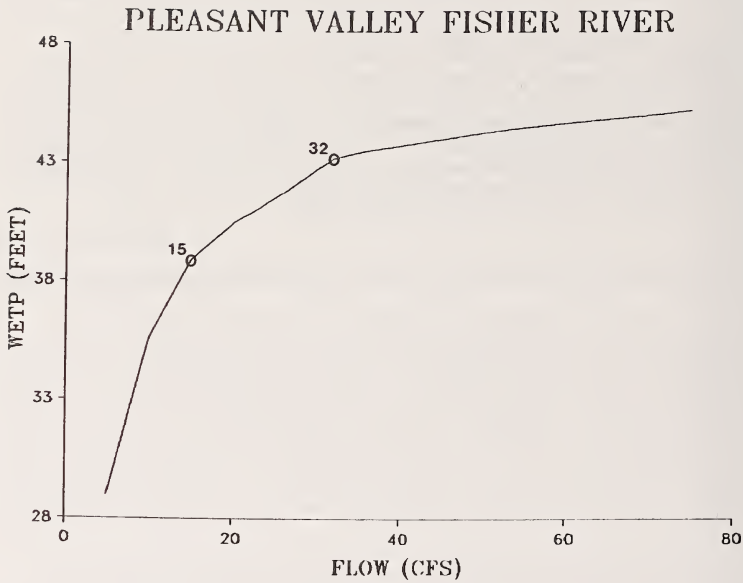

Figure 15. The wetted perimeter-discharge relationship for five riffle transects on Pleasant Valley Fisher River, 1987.

An average depth of 0.5 ft, the minimum requirement for the successful passage of migrant fish, is not reached in all transects until the flow equals or exceeds 47 cfs (Table 20). A flow of 47 cfs is therefore recommended for the period from April 1 through June 30 to ensure the successful passage of migrants during the spring spawning run and prevent the dewatering of redds.

Table 20. The average depths in five riffle cross sections on Pleasant Valley Fisher River at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
15	.54	.31	.27	.60	.33
32	.60	.41	.41	.75	.46
47	.69	.50	.50	.84	.55

MCGINNIS CREEK

Description

Stream reach: McGinnis Creek from its confluence with Pleasant Valley Fisher River (Sec. 1, T27N, R38W) to the source (Sec. 17, T25N, R28W) (Figure 14).

Stream length: 13.4 km. Total drainage area: 117 km^2. Gradient: 10 m per km.

Source and Land Use

McGinnis Creek originates on the eastern slope of an unnamed peak which is the highest point in the drainage at 1,652 m (5,421 ft) elevation. Seven third-order tributaries enter the stream before its confluence with Pleasant Valley Fisher River at an elevation of 927 m (3,020 ft).

Approximately 70 percent of the drainage area is privately owned, primarily by Champion International Corporation and a smaller amount by private individuals. The majority of the stream valley bottom is in private ranch land. The remaining acreage is held by the State of Montana and the U.S. Forest Service. Timber production, cattle grazing and forage production are the major land uses in the drainage.

Flows

Few flow data have been collected on McGinnis Creek except for sporadic measurements by personnel of the Montana Department of Fish, Wildlife and Parks and the Kootenai National Forest. Estimated mean annual discharge is 30.6 cfs.

Potential Environmental Problems

Water appropriations for McGinnis Creek total 32.7 cfs (MDNRC 1987). If all water users exercise their water rights to the fullest extent, the stream could potentially be dewatered. It is unknown, however, what percentage of existing claims are valid or presently in use.

Riparian grazing and timber cover loss due to forest fire and harvest is extensive in the watershed. Low stream gradient may limit sediment flushing ability. These factors combined may cause or increase stream bank degradation, sediment loading, and magnify peak flow events which could degrade channel stability and fisheries habitat.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on July 14, by a two-pass application of the removal method, using backpack electroshocking equipment. The 351-m electrofishing reach was located approximately 1.4 km from the mouth (SE 1/4, Sec. 1, T26N, R29W). Average stream width was 4.27 m and the discharge was 8.3 cfs, at the time of sampling. Game fish population was composed of nearly equal numbers of *Salmo* spp. and eastern brook trout (Table 21). One mountain whitefish was also captured. See Appendix B14 and B15 for the length distributions of all fish captured.

Flow Recommendations

Five permanent transects were established on riffle areas located approximately 1.2 km from the mouth of McGinnis Creek (SE 1/4, Sec. 1, T26N, R29W). The WETP program was calibrated to stage and discharge measurements at flows of 23.6, 13.5 and 8.3 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 6 and 12 cfs, respectively (Figure 16). Based on an evaluation of the existing fishery and results of the wetted perimeter analysis, a minimum discharge of 12 cfs is recommended for the low flow period from July 1 through March 31.

An average depth of 0.5 ft, the minimum requirement for successful passage of migrant fish, is not reached in all transects until the flow equals or exceeds 20 cfs (Table 22). A flow of 20 cfs is therefore recommended for the period from April 1 through June 30 to ensure the successful passage of migrants and prevent dewatering of redds.

Table 21. The results of a two-pass population evaluation of *Salmo* spp. and eastern brook trout ≥75 mm in McGinnis Creek (SE 1/4, Sec. 1, T26N, R29W) during July 1987. Discharge 8.3 cfs.

	EBT	*Salmo* spp.
Fish captured in sample section	73	76
Fish estimated in sample section	93 ± 26	97 ± 27
Fish estimated per kilometer	266 ± 74	277 ± 77
Fish estimated per acre	251 ± 70	262 ± 73
Average length of fish captured (mm)	101	114

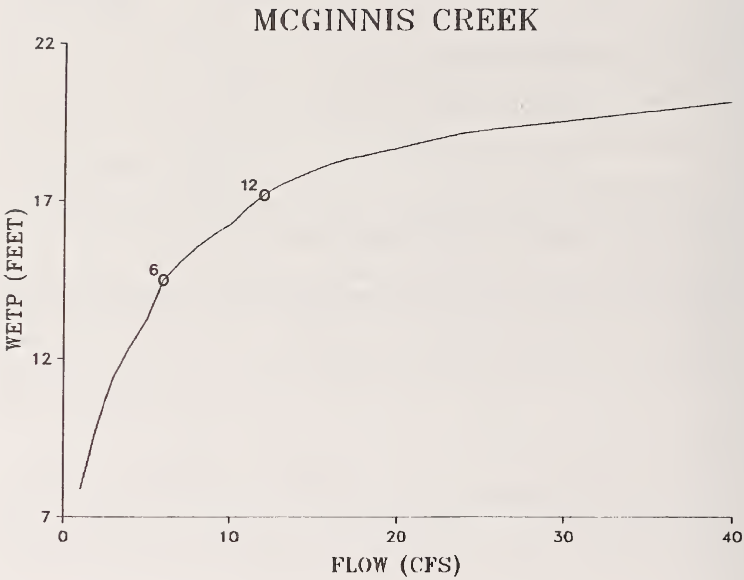

Figure 16. The wetted perimeter-discharge relationship for five riffle transects on McGinnis Creek, 1987.

Table 22. The average depths in five riffle cross sections on McGinnis Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
6	.49	.38	.24	.29	.97
12	.75	.51	.38	.37	1.18
20	.96	.62	.57	.50	1.36

EAST FISHER CREEK

Description

Stream reach: East Fisher Creek from its confluence with Silver Butte Fisher River (Sec. 30, T26N, R29W) to its source (Sec. 25, T25N, R28W) (Figure 14).

Stream length: 10.4 km. Total drainage area: 93.5 km^2. Gradient: 9 m per km.

Source and Land Use

East Fisher Creek originates on the north side of Willow Creek Pass 1,131 m, (3,711 ft) elevation. Allen Peak, at 2,054 m (6,740 ft) elevation, is the highest point in the drainage. The stream flows through Sylvan and Miller lakes located within 4.0 km from the source. Four third-order tributaries enter East Fisher Creek before it joins Silver Butte Fisher River at an elevation of 963 m (3,160 ft) elevation.

Checkerboard land ownership patterns characterize the drainage. The U.S. Forest Service holds approximately 50 percent of the drainage. The remaining acreage is privately owned, with Burlington Northern Railroad having the largest share, followed by Champion International Corporation and private individuals. The majority of lands adjacent to the stream are privately owned. Primary land uses in the drainage are timber production, cattle ranching and recreation. A U.S. Forest Service administered campground is located on Sylvan Lake.

Flows

Few flow data have been obtained on East Fisher Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 34.4 cfs.

Potential Environmental Problems

Forest Road 154 crosses East Fisher Creek three times. Although these stream fords do not currently appear to be a problem, they are a potential source of sediment and petroleum pollutants. Without periodic monitoring and taking protective measures, this situation may degrade in the future.

Cattle grazing, common along much of the upper half of the stream course, may lead to bank degradation and sediment input to the stream. Seepage from hard rock mining in the drainage occurred for 40 years (Schmidt and Botz 1978). Timber harvest and roads in the drainage have the potential to increase peak flows and sediment loading which may degrade channel stability and fish habitat (Rasmussen and Culwell 1978). These negative impacts are

more likely to be realized due to the difficulties that checkerboard ownership imposes on the coordination of land management activities.

Man-made Miller Lake has the potential to negatively influence stream flows in East Fisher Creek.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on August 12, by the mark-recapture method, using backpack electroshocking gear. A 213-m electrofishing section was chosen 0.4 km upstream from the mouth (SW 1/4, Sec. 30, T26N, R29W). Average stream width of the electrofishing section was 7.6 m and discharge at the time of sampling was 10.5 cfs. Game fish consisted primarily of rainbow trout (Table 23), and secondarily of eastern brook trout and mountain whitefish. Rainbow fry were observed to be common. See Appendix B16 for a length-frequency histogram of rainbow trout captured.

Flow Recommendations

Five permanent transects were established in riffle areas in East Fisher Creek approximately 0.5 km upstream from the mouth (SW 1/4, Sec. 30, T26N, R29W). The WETP program was calibrated to stage and discharge measurements at flows of 70, 47.5 and 10.5 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 9 and 15 cfs, respectively (Figure 17). Based on existing fish populations, results of the wetted perimeter analysis, and estimated water availability, a flow of 15 cfs is recommended for the period from July 1 through March 31.

An average depth of 0.5 ft, the minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 35 cfs (Table 24). Therefore, a flow of 35 cfs is recommended in East Fisher Creek for the period from April 1 through June 30 to ensure the successful passage of spring migrants and prevent dewatering of spawning redds.

Table 23. The results of a mark-recapture population evaluation of rainbow trout $\geq$75 mm in East Fisher Creek (SW 1/4, Sec. 30, T26N, R29W) during August 1987. Discharge 10.5 cfs.

	RB
Fish captured in sample section	61
Fish estimated in sample section	134 $\pm$ 65
Fish estimated per kilometer	638 $\pm$ 310
Fish estimated per acre	333 $\pm$ 162
Average length of fish captured (mm)	114

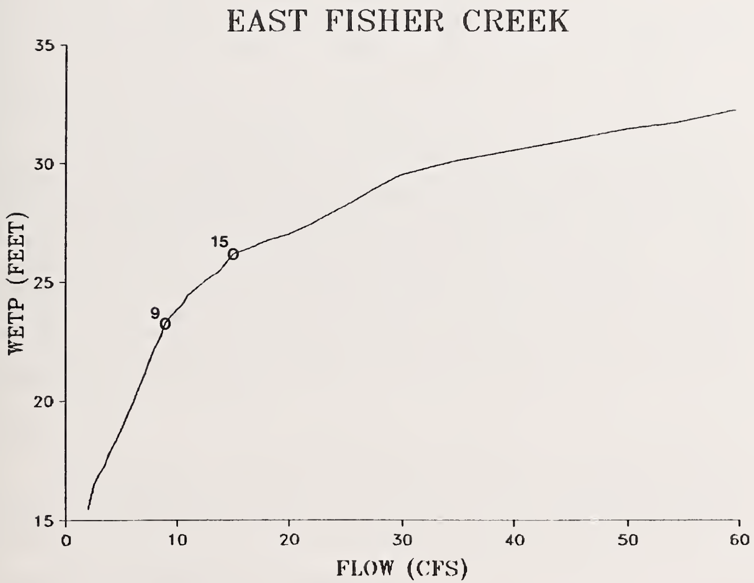

Figure 17. The wetted perimeter-discharge relationship for five riffle transects on East Fisher Creek, 1987.

Table 24. The average depths in five riffle cross sections on East Fisher Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
9	.21	.55	.30	.43	.40
15	.33	.65	.40	.50	.40
35	.60	.85	.59	.71	.50

SILVER BUTTE FISHER RIVER

Description

Stream Reach: Silver Butte Fisher River from its confluence with Pleasant Valley Fisher River (Sec. 9, T26N, R29W) to the source (Sec. 16, T26N, R30W) (Figure 14).

Stream length: 13.2 km. Total drainage area: 119 km^2. Gradient: 16 m per km.

Source and Land Use

Silver Butte Fisher River originates on the west slopes of the southern Cabinet Mountains. The highest point in the drainage is Allen Peak at 2,054 m (6,740 ft) elevation. Nine third- and fourth-order tributaries enter the stream before its confluence with Pleasant Valley Fisher River at 902 m (2,960 ft) elevation. Private ownership accounts for approximately 35 percent of the drainage area. Burlington Northern Railroad is the major private landowner followed by Champion International Corporation and private individuals. The U.S. Forest service holds the remaining acreage. Timber production is the primary land use in the drainage followed to a lesser extent by mining, recreation and residential development.

Flows

Few discharge records have been obtained on Silver Butte Fisher except for sporadic measurements by personnel of the Montana Department of Fish, Wildlife and Parks and the Kootenai National Forest. Estimated mean annual discharge is 88.6 cfs.

Potential Environmental Problems

Channel instability characterizes the lower ten to 12 km of the stream; channel migration and bank cutting are common. Timber harvest and roads in the drainage have the potential to increase sediment loading and magnify peak flow events which may further degrade channel stability and impact fish habitat (Rasmussen and Culwell 1978). Potential pollution from mine-tailing seepage could negatively influence stream productivity (Schmidt and Botz 1978).

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on August 26, by a three-pass application of the removal method, using backpack electroshocking equipment. A 183-m sample section, located approximately one km upstream from the mouth was chosen (SE 1/4, Sec. 17, T26N, R29W). Average stream width of the electrofishing

section was 7.9 m, and discharge at the time of sampling was 15.5 cfs. Game fish captured were predominantly rainbow followed in abundance by eastern brook trout. Low capture probability ($p<0.5$) for eastern brook trout precluded a precise population estimate, therefore only minimum estimates are presented (Table 25). See Appendix B17 and B18 for the length distribution of all fish captured.

Flow Recommendations

Five permanent transects were established on riffle and run areas located approximately one km upstream from the mouth of Silver Butte Fisher River (SW 1/4, Sec. 9, T26N, R29W). The WETP program was calibrated to stage and discharge measurements at flows of 214.6, 91.8, 16.1 and 10.0 cfs. The lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at flows of 6.5 and 34 cfs, respectively (Figure 18). Based on an evaluation of the existing fishery and results of the wetted perimeter analysis, a minimum discharge of 34 cfs is recommended for all periods of the year.

An average depth of 0.5 ft, the minimum requirement for successful passage of migrant fish, is not reached in all transects until the flow equals or exceeds 22 cfs (Table 26). At the recommended flow of 34 cfs, water depth in the shallowest transect is sufficient for the successful passage of migrant fish. Therefore a specific passage flow is not requested.

Table 25. The results of a two-pass population evaluation of rainbow and eastern brook trout $\geq$75 mm in Silver Butte Fisher River (SE 1/4, Sec. 17, T26N, R29W) during August 1987. Discharge 15.5 cfs.

	EBT	RB
Fish captured in sample section	14	35
Fish estimated in sample section	14	48 $\pm$ 26
Fish estimated per kilometer	78	267 $\pm$ 144
Fish estimated per acre	39	133 $\pm$ 72
Average length of fish captured (mm)	98	120

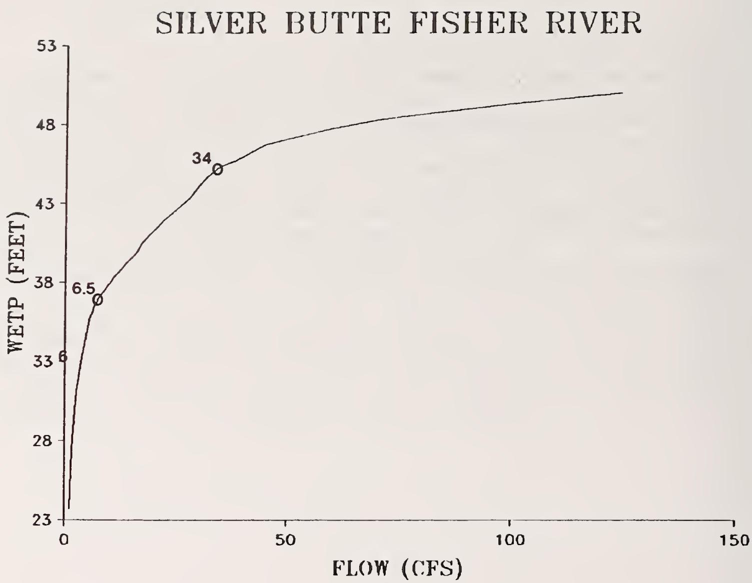

Figure 18. The wetted perimeter-discharge relationship for five riffle transects on Silver Butte Fisher River, 1987.

Table 26. The average depths in five riffle cross sections on Silver Butte Fisher River at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
6.5	.57	.54	.56	.25	.64
22.0	.80	.71	.82	.50	.90
34.0	.88	.80	.82	.62	1.02

WEST FISHER CREEK

Description

Stream reach: West Fisher Creek from its confluence with Fisher River (SE 1/4, Sec. 30, T27N, R29W) to its source (Sec. 33, SW 1/4, T26N, R31W) (Figure 14).

Stream length: 21.2 km. Total drainage area: 109.6 km^2. Gradient (lower 18 km): 15.8 m per km.

Source and Land Use

West Fisher Creek originates on the east slope of the Cabinet Mountains. Flat Top Mountain (2,313 m) is the highest point in the drainage. West Fisher Creek joins the main Fisher River at 867 m (2,910 ft) elevation. West Fisher Creek is a fourth-order stream fed by five second- and third-order streams. Burlington Northern owns 15 percent of the drainage, four percent is in mining claims and privately owned, one section is owned by the State of Montana, and the remaining 79 percent of the drainage is held by the U.S. Forest Service. Timber production, mining, and recreation are the primary land uses in the drainage.

Flows

Little flow data have been obtained on West Fisher Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 59 cfs.

Potential Environmental Problems

Timber harvest, mining, and roads have the potential to increase sediment loading, and magnify peak flow events to the detriment of the fishery.

Fish Populations

A population estimate was obtained on September 1, by a two-pass application of the removal method using bank shocking equipment. A 187-m section was chosen that had an average width of 6.1 m and a discharge of 12 cfs at the time of sampling (NE 1/4, Sec. 31, T27N, R30W). Game fish were composed almost exclusively of rainbow trout (Table 27), with small numbers of brook trout (four) and mountain whitefish (two) also captured. Observations during electrofishing indicated sculpins to be abundant and dace rare. Rainbow trout fry were also observed. A length frequency histogram is provided (Appendix B19).

Table 27. The results of a two-pass population evaluation of rainbow trout $\geq$75 mm in West Fisher Creek (NE 1/4, Sec. 31, T27N, R30W) during September 1987. Discharge 12 cfs.

	RB
Fish captured in sample section	61
Fish estimated in sample section	83 $\pm$ 36
Fish estimated per kilometer	444 $\pm$ 193
Fish estimated per acre	294 $\pm$ 127
Average length of fish captured (mm)	110

Flow Recommendations

Five permanent transects were established in riffle areas in West Fisher Creek (NW 1/4, Sec. 31, T27N, R30W). The WETP program was calibrated to stage and discharge measurements at flows of 232.8, 174, 12.3 and 8.7 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 6 and 28 cfs, respectively (Figure 19). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 28 cfs is recommended for the low flow period from July 1 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 75 cfs (Table 28). A passage flow of 75 cfs is therefore recommended from April 1 through June 30 to ensure successful migration of fish during the spring spawning run.

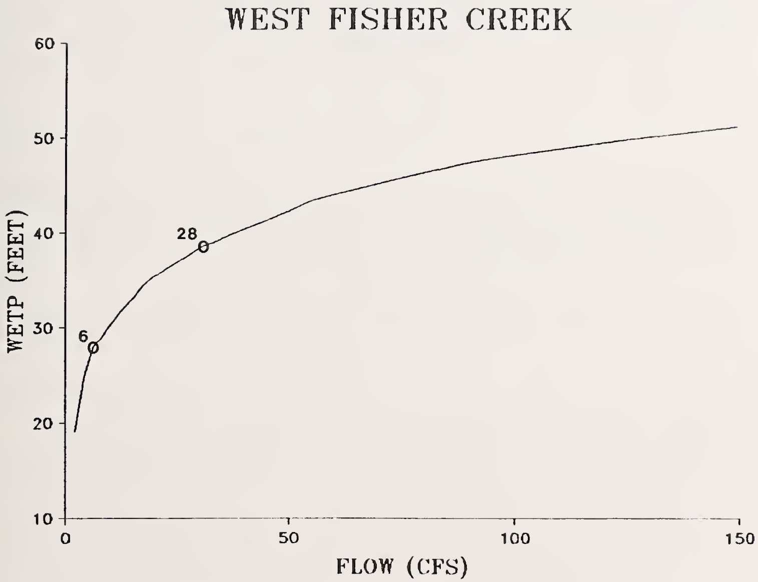

Figure 19. The wetted perimeter-discharge relationship for five riffle transects on West Fisher Creek, 1987.

Table 28. The average depths in five riffle cross sections on West Fisher Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
6	.31	.49	.46	.18	.26
28	.59	.82	.78	.55	.34
75	.73	1.03	1.14	.82	.50

Libby Creek Subdrainage

Libby Creek is one of four major spawning tributaries in the Montana portion of the Kootenai River drainage. Instream flow requirements of two reaches in the main stem of Libby Creek and one reach in Big Cherry Creek below its confluence with Granite Creek were described by May (1982) and Marotz and Fraley (1986). Major tributaries and forks of Libby Creek are included here and further refine the instream flow needs in the drainage (Figure 39).

GRANITE CREEK

Description

Stream reach: Granite Creek from its junction with Big Cherry Creek (NW 1/4, Sec. 2, T30N, R30W) to Granite Lake (Sec. 27, T29N, R32W), its source at 1,402 m elevation (Figure 20).

Stream length: 19.2 km. Total drainage area: 72.1 km^2. Gradient: 31 m per km.

Source and Land Use

Granite Creek originates on the east slope of the Cabinet Mountains. The highest point in the drainage is Snowshoe Peak at 2,663 m (8,738 ft) elevation. Granite Creek joins Big Cherry at an elevation of 732 m (2,401 ft). Champion International Corporation owns three percent of the drainage, one percent is in private ownership, and the remaining 96 percent is held by the U.S. Forest Service. Timber production, mining, grazing, and recreation are the primary land uses in the drainage.

Flows

A continuous stage recording station was maintained on Granite Creek by the U.S. Geological Survey from January through December 1933, August 1936 through November 1943, and August 1960 through October 1969. Since 1986, the U.S. Forest Service has maintained a continuous stage recording station on Granite Creek (NE 1/4, Sec. 3, T29N, R31W). Mean monthly discharge and eightieth percentile exceedance flows for Granite Creek are presented in Figure 21.

Potential Environmental Problems

Water appropriations for domestic use and mining total 33.14 cfs. Much of the lower portion of Granite Creek is characterized by a wide valley bottom with side channels dammed by beavers. Excessive withdrawals could detrimentally affect not only the primary channel, but also the broader riparian zone.

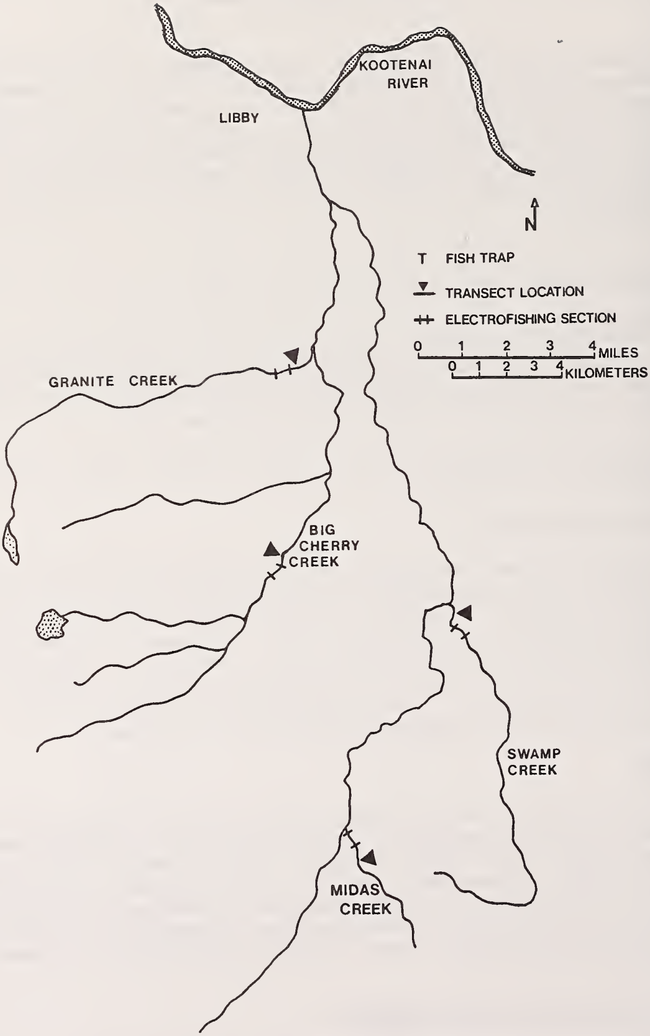

Figure 20. The Libby Creek subdrainage.

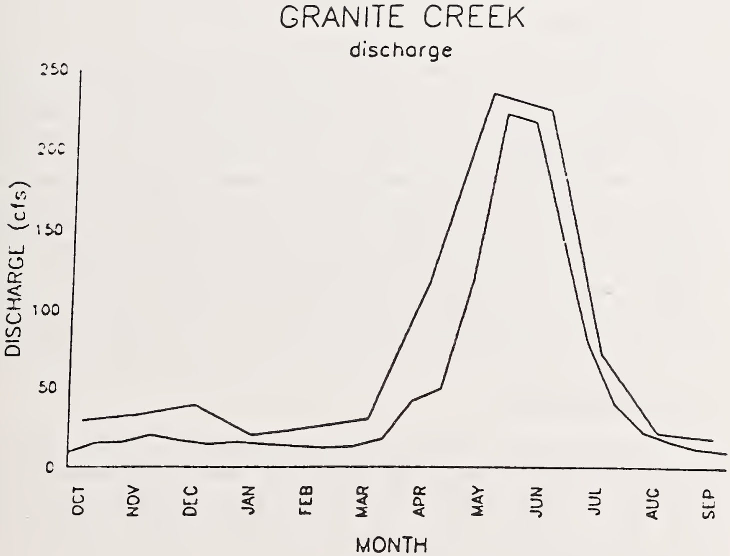

Figure 21. Mean monthly flows (top line) and eightieth percentile exceedence flows (bottom line) based on ten years of daily stage records for Granite Creek (USGS).

Granite Lake is one of the few unstocked lakes in the Cabinet Mountain Wilderness that has perpetuated a substantial fishery, and the maintenance of adequate flows in Granite Creek will ensure continued recruitment of fish from the lake to the rest of the stream system. Timber harvest, mining, and road construction have the potential to increase sediment loading, and magnify peak flow events to the detriment of the fishery (Rasmussen and Culwell 1978).

Fish Populations

A population estimate was obtained on August 9, by a three-pass application of the removal method using bank shocking equipment. A 164-m section was chosen above forest road 4791 bridge (NE 1/4, Sec. 3, T29N, R31W). While this section most closely represented the average stream condition, it was not ideal due to habitat limitations caused by channel instability; two deep pools could not be effectively sampled by the electrofishing gear. These factors may have negatively biased the population estimate. Game fish were comprised almost exclusively of rainbow trout (Table 29), with brook trout occurring in limited numbers. Six brook trout and two mountain whitefish were also captured. Average stream width in the sampled section was 8.5 m, and the discharge at the time of sampling was 11.7 cfs. A length-frequency histogram of rainbow trout captures is provided (Appendix B20).

Flow Recommendations

Five permanent transects were established in riffle areas in Granite Creek from just below the Forest Road 4791 bridge to just above the confluence with Big Cherry Creek, 0.8 km downstream (NE 1/4, Sec. 3, T29N, R31W). The WETP program was calibrated to stage and discharge measurements at flows of 169.1, 71.6 and 11.7 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 21 and 50 cfs, respectively (Figure 22). Based on existing fish populations, results of the wetted perimeter analysis, and estimated water availability, a flow of 21 cfs is recommended for the period from July 1 through March 31.

At the recommended flow of 21 cfs, water depth at the shallowest transect is sufficient for successful passage of migrant fish (Table 30). Fish passage should not be a problem if recommended flows are maintained (Table 31). Recommended flows amount to 46 percent of mean annual discharge on record.

Table 29. The results of a three-pass population evaluation of rainbow trout $\geq$75 mm in Granite Creek (NE 1/4, Sec. 3, T29N, R31W) during August 1987. Discharge 11.7 cfs.

	RB
Fish captured in sample section	49
Fish estimated in sample section	55 $\pm$ 10
Fish estimated per kilometer	335 $\pm$ 61
Fish estimated per acre	160 $\pm$ 29
Average length of fish captured (mm)	124.5

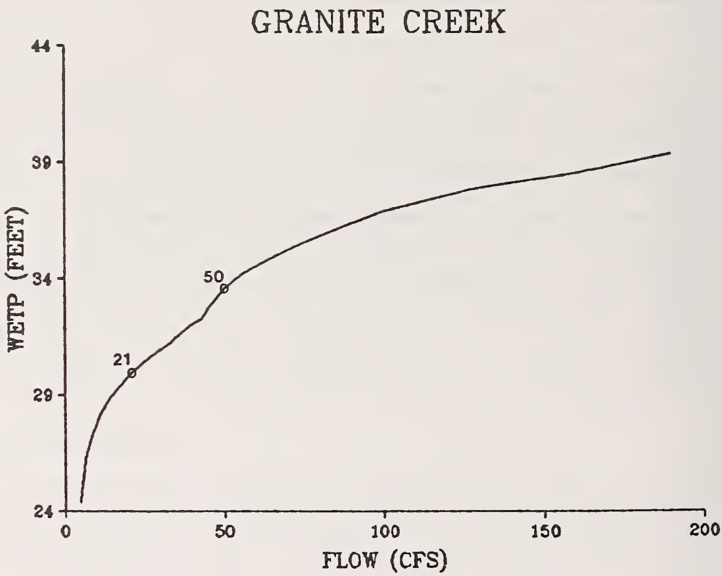

Figure 22. The wetted perimeter-discharge relationship for five riffle transects on Granite Creek, 1987.

Table 30. The average depths in five riffle cross sections on Granite Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
21	.80	.69	.64	.50	.61
50	.91	.94	.92	.72	.84

Table 31. Recommended flows for Granite Creek and historical water availability records based on 99 months of daily records (USGS).

Period of Water Year	Recommended Flow	80% Exceedance Flow	Mean Flow	Acre Feet
Oct. 1-15	21	8.94	20.3	604.0
16-31	21	15.2	28.4	666.4
Nov. 1-15	21	15.7	28.1	624.8
16-30	21	20.0	31.5	624.8
Dec. 1-15	21	16.7	24.4	624.8
16-31	21	14.5	19.9	631.5
Jan. 1-15	21	15.7	20.0	595.0
16-31	21	14.31	20.3	644.2
Feb. 1-15	21	13.1	29.4	624.8
16-28	21	12.2	21.2	499.9
Mar. 1-15	21	12.7	20.9	621.8
16-31	21	17.3	30.6	666.4
Apr. 1-15	21	40.7	62.3	624.8
16-30	21	48.5	85.4	624.8
May 1-15	50	118.4	161.8	1,517.4
16-31	200[a]	221.3	293.4	6,347.8
June 1-15	50	216.0	278.7	1,517.4
16-30	21	145.5	192.0	924.8
July 1-15	21	79.2	98.1	624.8
16-31	21	39.6	46.5	666.4
Aug. 1-15	21	22.1	27.3	624.8
16-31	21	16.1	19.4	615.7
Sep. 1-15	21	12.0	14.6	434.4
16-30	21	10.2	15.7	467.1

a/ A dominant discharge flow (approximated bankfull flow presently undefined) should be maintained for 24 hours during this period.

BIG CHERRY CREEK

Description

Stream reach: Big Cherry Creek from its junction with Granite Creek (NW 1/4, Sec. 2, T30N, R30W) to Big Cherry Lake (Sec. 23, T28N, R32W), its source at 1,783 m elevation (Figure 20).

Stream length: 25.2 km. Total drainage area: 124.8 km^2. Gradient: 20 m per km.

Source and Land Use

Big Cherry Creek originates on the east slope of the Cabinet Mountains. The highest point in the drainage is Alaska Peak at 2,135 m (7,005 ft). Before reaching Granite Creek at 732 m (2,402 ft) elevation, Big Cherry Creek picks up five second-order streams. Land ownership in the drainage is as follows: less than one percent in mining claims, four percent owned by Champion International Corporation, two percent held by the State of Montana, three percent in private ownership, and the remaining 90 percent is held by the U.S. Forest Service. Timber production and mining are the primary land uses in the drainage.

Flows

Few flow data have been obtained on Big Cherry Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 51.7 cfs.

Potential Environmental Problems

Water appropriations listed for Big Cherry Creek total 5.44 cfs. The creek channel in the lower four miles of the stream is characteristically unstable. A braided channel form is common, and this condition can negatively affect water depth, especially during low flow periods. Increased timber harvesting, road construction, and mining have the potential to increase both sediment loading and the occurrence of damaging peak flow events.

High lead concentrations in the stream and zinc from abandoned mine tailings on Snowshoe Creek is limiting productivity in Snowshoe and Big Cherry creeks (May 1982, Schmidt and Botz 1978).

A major diversion of flow out of Big Cherry Creek exists in order to supply privately owned Double N Lake.

Fish Populations

A population estimate was obtained on August 24, by means of the mark-recapture method using bank electroshocking equipment. A 260-m section was chosen about one km upstream from forest road

867 bridge (SW 1/4, Sec. 27, T29N, R31W). Game fish were composed almost exclusively of rainbow trout (Table 32). Six brook trout were also captured. Average stream width in the sampled section was 9.1 m, and the discharge at the time of sampling was 11.7 cfs. All parts of the stream reach sampled were accessible to electrofishing gear except for a 10-m long, plunge pool complex. A length-frequency histogram of rainbow trout captures is provided (Appendix B21).

Flow Recommendations

Five permanent transects were established in riffle areas in Big Cherry Creek, two above and three below the forest road 867 bridge (SW 1/4, Sec. 27, T29N, R31W), which is about 6.4 km above the confluence with Granite Creek. The WETP program was calibrated to stage and discharge measurements at flows of 129.5, 60.8 and 11.7 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 14 and 40 cfs, respectively (Figure 23). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 40 cfs is recommended for all periods of the year.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 30 cfs (Table 33). At the recommended flow reservation of 40 cfs, the average depth of the shallowest transect is sufficient for successful passage of migrant fish. Therefore installation of the recommended flow year-round will accommodate the needs of migrant fish, and consequently a specific passage flow is not requested.

Table 32. The results of a mark-recapture population evaluation of rainbow trout $\geq$75 mm in Big Cherry Creek (SW 1/4, Sec. 27, T29N, R31W) during August 1987. Discharge 11.7 cfs.

	RB
Fish captured in sample section	319
Fish estimated in sample section	375 $\pm$ 34
Fish estimated per kilometer	1227 $\pm$ 131
Fish estimated per acre	220 $\pm$ 20
Average length of fish captured (mm)	102

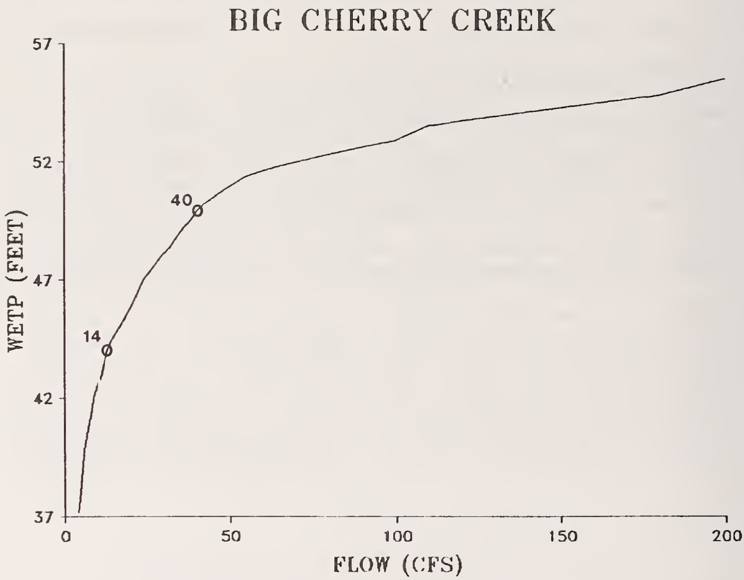

Figure 23. The wetted perimeter-discharge relationship for five riffle transects on Big Cherry, 1987.

Table 33. The average depths in five riffle cross sections on Big Cherry Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
14	.48	.42	.37	.44	.37
30	.66	.55	.50	.60	.55
40	.72	.61	.54	.67	.64

SWAMP CREEK

Description

Stream reach: Swamp Creek from the mouth on Libby Creek (SW 1/4, Sec. 32, T29N, R30W) to the headwaters draining Horse Mountain (NW 1/4, Sec. 4, T28N, R30W) (Figure 20).

Stream length: 15.3 km. Total drainage area: 68.9 km^2. Gradient (last 13 km): 28.1 m per km.

Source and Land Use

Swamp Creek originates on the east side of Horse Mountain (1,770 m, 5,806 ft), and flows east then north to join Libby Creek at 832 m (2,730 ft) elevation. Champion International Corporation owns 14 percent of the drainage, eight percent is in private ownership, and the remaining 78 percent is held by the U.S. Forest Service. Timber production, grazing, and hay production are the primary land uses in the drainage.

Flows

Few flow data have been obtained on Swamp Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 16.8 cfs.

Potential Environmental Problems

Water appropriations listed for Swamp Creek total 6.73 cfs. Potential use of Swamp Creek as a spawning tributary to Libby Creek is inhibited by two factors. Libby Creek has a history of excessive peak flows. Bedload deposition has created an impoundment of Swamp Creek at the mouth which may inhibit the migration of fish into Swamp Creek to spawn. Another factor is a wooden dam structure located about one km upstream from the mouth which probably acts as a barrier to fish passage.

Grazing occurs along much of the stream's course presenting a potential for bank erosion and habitat degradation. The 2.9 percent gradient of Swamp Creek is unusually low for a second- to third-order stream of this area, and suggests a limited capacity to flush sediment. Road building and timber harvest in the drainage may aggravate this sensitivity.

Fish Populations

A population estimate was obtained on September 12, by a two-pass application of the removal method using a backpack electroshocker. A 137-m section was chosen which extended downstream from the Farm-to-Market bridge near the junction with Highway 2 (NW 1/4, Sec. 4, T28N, R30W). Channelization for highway

construction and ease of accessibility to fishermen may have artificially reduced fish populations in the sampling reach. Therefore, the total population per kilometer may have been underestimated (Table 34). Brook trout were the most common species captured, rainbow, cutthroat trout and hybrids of the two were less common, and bull trout were present but uncommon. A precise estimate of the brook trout population was not obtained since the capture probability was too low. Instead, a minimum estimate equal to the number of fish captured is provided. An inadequate sample size precluded an estimate of the bull trout population.

Average stream width in the sampled section was 4.0 m, and the discharge at the time of sampling was 3.4 cfs. Length-frequency histograms are provided (Appendix B22 and B23).

Flow Recommendations

Five permanent transects were established in riffle areas in Swamp Creek one-half kilometer upstream from the mouth (NW 1/4, Sec. 4, T28N, R30W). The WETP program was calibrated to stage and discharge measurements at flows of 29.1, 8.3, 5.0 and 3.5 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 1 and 5 cfs, respectively (Figure 24). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 5 cfs is recommended for the low flow period from July 1 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 15.5 cfs (Table 35). A passage flow of 15.5 cfs is therefore recommended from April 1 through June 30 to ensure successful migration of fish during the spring spawning run.

Table 34. The results of a two-pass population evaluation of fish $\geq$75 mm in Swamp Creek (Libby) (NW 1/4, Sec. 4, T28N, R30W) during September 1987. Discharge 3.4 cfs.

	Salmo spp.	EBT
Fish captured in sample section	17	26
Fish estimated in sample section	21 $\pm$ 10	26
Fish estimated per kilometer	153 $\pm$ 73	190
Fish estimated per acre	156 $\pm$ 74	194
Average length of fish captured (mm)	138	125

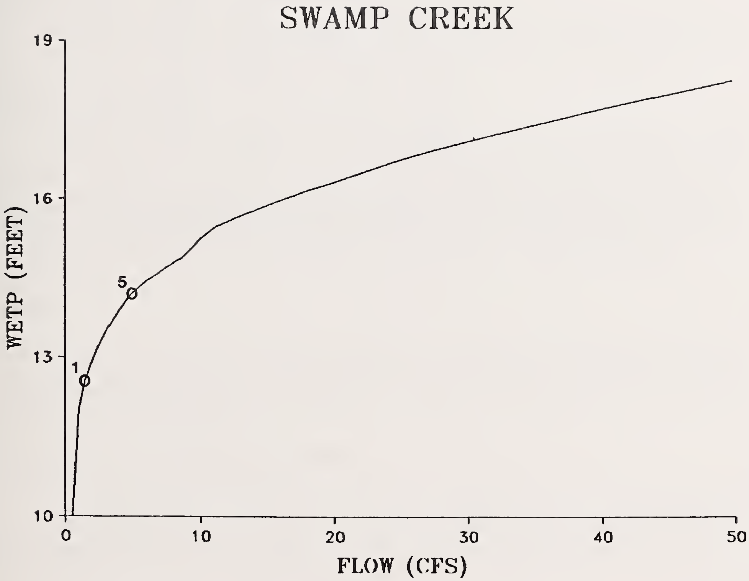

Figure 24. The wetted perimeter-discharge relationship for five riffle transects on Swamp Creek, 1987.

Table 35. The average depths in five riffle cross sections on Swamp Creek (Libby) at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
1.0	.10	.21	.16	.41	.14
5.0	.28	.36	.37	.56	.34
15.5	.50	.52	.56	.70	.55

MIDAS CREEK

Description

Stream reach: Midas Creek from the confluence with Libby Creek (Sec. 31, NW 1/4, T28N, R31W) to the source (Sec. 8, SW 1/4, T27N, R31W) (Figure 20).

Stream length: 40.2 km. Total drainage area: 16 km^2. Gradient: 61 m per km.

Source and Land Use

Midas Creek originates on an unnamed ridge separating it from Miller Creek to the south. The highest point in the drainage is Horse Mountain (1,770 m). Except for privately owned acres at the mouth, the drainage is entirely held by the U.S. Forest Service. Timber production is the primary land use. Grazing on a Forest Service allotment is of secondary importance in the drainage.

Flows

Few flow data have been obtained on Midas Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 5 cfs.

Potential Environmental Problems

Continued timber harvest and road construction in the drainage have the potential to increase sediment loading and the occurrence of damaging peak flow events. Use of the riparian zone by cattle has the potential to cause bank erosion.

Fish Populations

A population estimate was obtained on July 8, by a two-pass application of the removal method using backpack electrofishing gear. A 259-m section was chosen below forest road 231 bridge (NW 1/4, Sec. 31, T28N, R38W). The population consisted almost exclusively of rainbow trout (Table 36), with the only other species captured being a single bull trout.

Average stream width in the sampled section was 2.2 m and the discharge at the time of sampling was 0.65 cfs. A length-frequency histogram of rainbow trout captures is provided (Appendix B24).

Flow Recommendations

Five permanent transects were established in riffle areas in Midas Creek about 0.5 km upstream of forest road 231 (NW 1/4, Sec. 31, T28N, R31W). The WETP program was calibrated to stage and

Table 36. The results of a two-pass population evaluation of rainbow trout $\geq$75 mm in Midas Creek (NW 1/4, Sec. 31, T28N, R38W) during July 1987. Discharge 0.65 cfs.

	RB
Fish captured in sample section	48
Fish estimated in sample section	64 $\pm$ 27
Fish estimated per kilometer	246 $\pm$ 104
Fish estimated per acre	462 $\pm$ 195
Average length of fish captured (mm)	105

discharge measurements at flows of 12.6, 2.1 and 0.7 cfs. Inflection points occur at 0.9 and 1.50 cfs (Figure 25). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 1.5 cfs is recommended for the low flow period from July 1 through March 31.

It is assumed that the small size of Midas Creek makes it unlikely that fish larger than 20 inches utilize it for spawning. An average depth of 0.4 ft, which is required for passage of fish less than 20 inches, is not reached in all transects until the flow equals or exceeds 10.0 cfs (Table 37). A passage flow of 10.0 cfs is therefore recommended from April 1 through June 30 to ensure successful migration of fish during the spring spawning run.

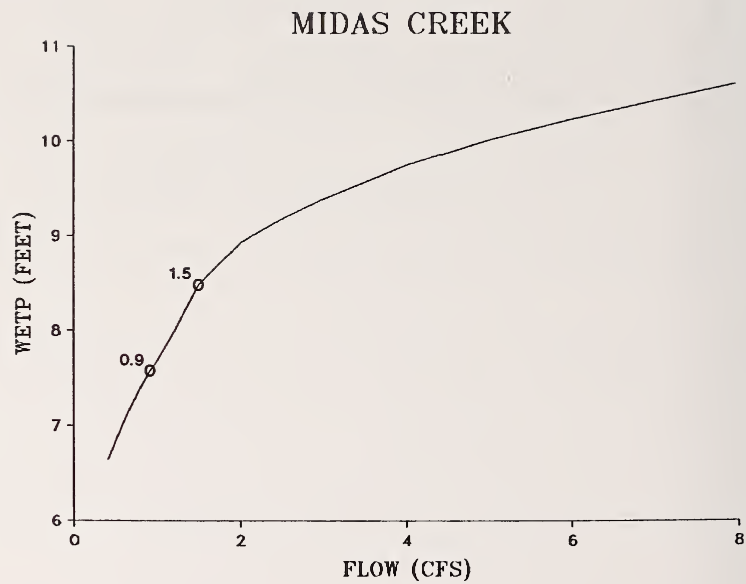

Figure 25. The wetted perimeter-discharge relationship for five riffle transects on Midas Creek, 1987.

Table 37. The average depths in five riffle cross sections on Midas Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
0.9	.19	.25	.24	.15	.20
1.5	.22	.30	.28	.16	.25
10.0	.42	.51	.58	.41	.47

Bull Lake Subdrainage

The Bull Lake subdrainage has been isolated from the Kootenai drainage by a dam. Spawning migrants from the Kootenai drainage and recruitment to the river is restricted to the 0.5-km reach below the existing hydropower facility. A significant resident population in the upper reaches offers an excellent sport fishery. Instream flow needs in Ross Creek, the headwater of the system, was described by May (1982) and was subsequently reanalyzed by Marotz and Fraley (1986). The results of the wetted perimeter analysis conducted in the other primary streams, Lake and Keeler creeks, are presented here (Figure 26).

LAKE CREEK

Description

Stream reach: Lake Creek from the inflow to Troy Reservoir (NE 1/4, Sec. 19, T31N, R33W) to the outflow from Bull Lake (Sec. 8, T29N, R33W) (Figure 26).

Stream length: 25.8 km. Total drainage area: 543.9 km^2. Gradient: 3.1 m per km.

Source and Land Use

Lake Creek's true origin is Ross Creek in the West Cabinet mountains. This report considers Lake Creek only from its origin as the outflow of Bull Lake (708 m, 2,333 ft) to its confluence with the Kootenai River (570 m, 1,870 ft). All of the riparian zone in the Lake Creek drainage is privately owned. Champion International Corporation owns nine percent, the State of Montana holds two percent, mining claims occupy less than one percent, private ownership includes six percent, and the U.S. Forest Service holds the remaining 82 percent of the drainage. Timber production, mining, grazing, forage production, residential development and recreation are the predominant land uses.

Flows

A continuously recording stage-discharge station was maintained by the U.S. Geological Survey, Water Resources Division from January 1945 to September 1957, and October 1982 to September 1983 (Sec. 18, T31N, R33W). Mean monthly flows based on 13 years of daily stage measurements are summarized in Figure 27. Mean annual discharge is 510 cfs.

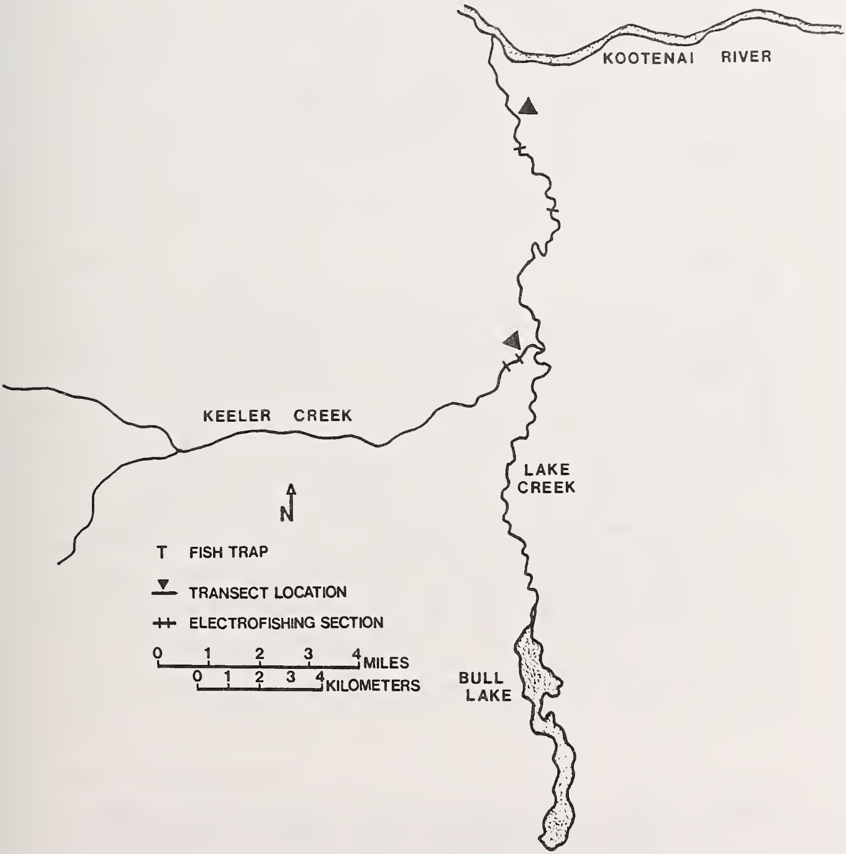

Figure 26. The Bull Lake subdrainage.

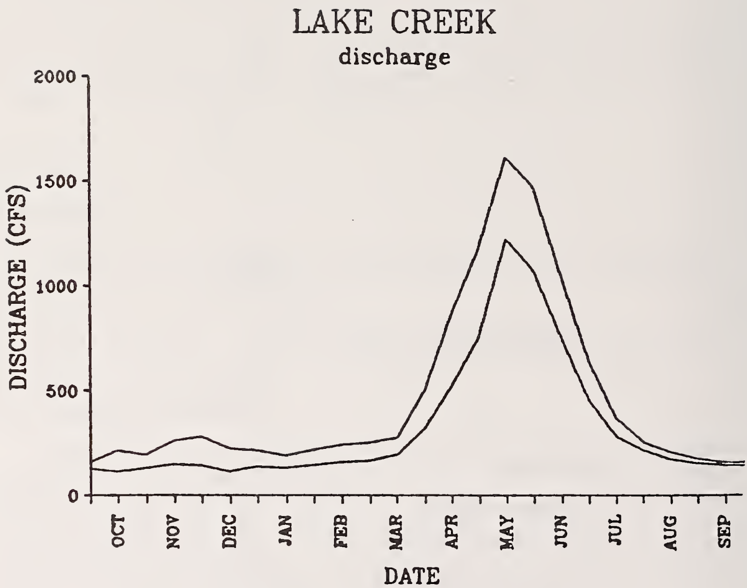

Figure 27. Mean semi-monthly flows (top line) and eightieth percentile exceedence flows (bottom line) based on ten years of daily stage records for Lake Creek (USGS).

Potential Environmental Problems

Montana Light and Power Company has a water right on Lake Creek equal to 540 cfs with a priority date of December 12, 1911.

A 400-acre tailing impoundment (Sec. 31 & 32, T29N, R33W) has the potential to degrade water quality in Lake Creek through the inadvertent input of contaminants such as heavy metals and fine sediments. Grazing has the potential to degrade the banks and increase sediment loading. Increased agriculture and residential development may increase water demands in the drainage. Timber production and roads have the potential to increase sediment loading and damaging peak flow events. Variable discharges from the Troy reservoir have the potential to negatively affect spawning success in Lake Creek below the dam.

Fish Populations

A population estimate was obtained on September 14, by the mark-recapture method in which a drift boat was used to transport the electrofishing gear. The recapture sample was taken on September 18. A stream section without block nets was chosen from the first bridge crossing upstream of the impoundment (SE 1/4, Sec. 32, T31N, R33W) to 1,830 m downstream. Sampling difficulties were extreme, as a result of the outstanding pool development characteristic of Lake Creek in which depth and cover reduce sampling efficiency by electrofishing. On a subjective basis, it is estimated that 30 percent of available habitat within the studied section could not be sampled. In addition, this problem resulted in reduced sampling efficiency of the larger size classes of fish. The estimated population therefore is significantly below the true population. Game fish were primarily rainbow trout and secondarily brook trout (Table 38). One mountain whitefish was captured, and long nose dace were observed to be common. Average stream width in the sampled section was 22 m, and the discharge at the time of sampling was 118 cfs. A length-frequency histogram of rainbow trout captures is provided (Appendix B25 and B26).

Flow Recommendations

Five permanent transects were installed in riffle areas in Lake Creek in a 0.5 km section of stream located 3.2 km upstream of the Troy Reservoir (NE 1/4, Sec. 30, T31N, R33W). The WETP program was calibrated to stage and discharge measurements at flows of 634.3, 260.9, 124.5 and 111.1 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 60 and 140 cfs, respectively (Figure 28). Based on existing fish populations, results of the wetted perimeter analysis, and estimated water availability, a flow of 140 cfs is recommended for the low flow period of the year, July 1 through March 31.

Table 38. The results of a mark-recapture population evaluation of rainbow and eastern brook trout ≥75 mm in Lake Creek (SE 1/4, Sec. 32, T31N, R33W) to 1,830 m downstream, during September 1987. Discharge 118 cfs.

	RB	EBT
Fish captured in sample section	199	70
Fish estimated in sample section	369 ± 33	70
Fish estimated per kilometer	205 ± 18	39
Fish estimated per acre	37 ± 3	7
Average length of fish captured (mm)	124	113

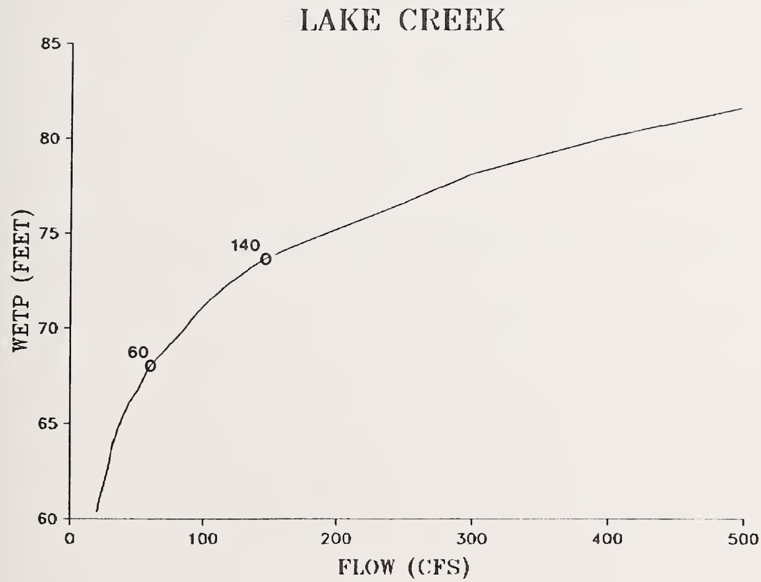

Figure 28. The wetted perimeter-discharge relationship for five riffle transects on Lake Creek, 1987.

At the recommended flow reservation of 140 cfs, water depth in the shallowest transect is sufficient for the successful migration of fish within the reach (Table 39). Fish passage should not be impaired if recommended flows are maintained (Table 40). Recommended flows amount to 49 percent of the mean annual discharge on record.

Table 39. The average depths in five riffle cross sections on Lake Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
36	.50	1.64	1.18	.84	1.17
60	.66	1.88	1.35	.99	1.42
140	.96	2.26	1.65	1.40	1.89

Table 40. Recommended flows for Lake Creek and historical water availability records based on 14 years of daily records (USGS).

Period of Water Year	Recommended Flow	80% Exceedence Flow	Mean Flow	Acre Feet
Oct 01-15	140	128.0	157.9	4,165.3
Oct 16-31	140	112.7	213.9	4,443.0
Nov 01-15	140	128.6	192.4	4,165.3
Nov 16-30	140	147.1	259.1	4,443.0
Dec 01-15	140	141.2	279.1	4,165.3
Dec 16-31	140	113.2	222.3	4,443.0
Jan 01-15	140	136.9	214.9	4,165.3
Jan 16-31	140	130.4	189.9	4,443.0
Feb 01-15	140	143.5	216.6	4,165.3
Feb 16-28	140	157.2	240.7	3,609.9
Mar 01-15	140	164.1	251.0	4,165.3
Mar 16-31	140	191.9	272.7	4,443.0
Apr 01-15	200	319.2	499.2	5,950.4
Apr 16-30	350	520.9	866.1	10,410.7
May 01-15	600	756.5	1,177.1	17,847.0
May 16-31	1,200[a/]	1,220.6	1,610.6	38,073.6
Jun 01-15	600	1,073.0	1,474.0	17,847.0
Jun 16-30	350	753.6	1,045.5	10,410.7
Jul 01-15	200	452.7	638.8	5,950.4
Jul 16-31	140	282.3	367.8	4,443.0
Aug 01-15	140	216.9	254.7	4,165.3
Aug 16-31	140	172.3	206.4	4,443.0
Sep 01-15	140	153.1	175.3	4,165.3
Sep 16-30	140	142.5	157.2	4,443.0
				166,509

a/ A dominant discharge flow (approximated bankfull flow presently undefined) should be maintained for 24 hours during this period.

KEELER CREEK

Description

Stream reach: Keeler Creek from the confluence with Lake Creek (SW 1/4, Sec. 17, T30N, R33W), to the headwaters (SW 1/4, Sec. 34, T58N, R3E) (Figure 26).

Stream length: 19 km. Total drainage area: 136 km^2. Gradient (lower 14 km): 19.4 m per km.

Source and Land Use

Keeler Creek originates in Idaho on the east face of Benning Mountain (2,010 m, 6,594 ft) and flows east to its confluence with Lake Creek at 671 m (2,200 ft) elevation. The drainage, especially the headwaters, is predominantly held by the U.S. Forest Service (91 percent, 30.854 acres), while Champion International Corporation owns six percent (1,920 acres) of the drainage, which includes about 8 km of the lower Keeler Creek. riparian zone. The State of Montana owns one percent (210 acres) and two percent (640 acres) is privately owned. Timber production is the primary land use, with grazing, mining, and residential uses being of minor importance.

Flows

Little flow data have been obtained on Keeler Creek except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 86.5 cfs.

Potential Environmental Problems

Timber harvest and roads have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat.

The Keeler Creek channel is still in a destabilized condition following extreme harvest activities and poor road locations, especially between 1941 and 1970. During that period, over 100,000 million board feet was removed from 5,780 clear-cut acres. Serious flooding occurred in 1974 and 1980.

Fish Populations

A population estimate was obtained on August 31, by a two-pass application of the removal method using bank shocking equipment. A 160-m section was chosen immediately above the Lake Creek Road bridge (NE 1/4, Sec. 19, T30N, R33W). A mixed population of game fish was found to consist of bull, brook, and rainbow trout. Sculpins were common in the sampled section. Inadequate sample size (six fish captured in two passes) precludes a rainbow trout

estimate. The results of the bull and brook trout estimates are presented in Table 41. Average stream width at the time of sampling was 10.7 m, and the discharge was 17.1 cfs.

Flow Recommendations

Five permanent transects were established in riffle areas in Keeler Creek immediately above Lake Creek Road bridge (NE 1/4, Sec. 19, T30N, R33W). The WETP program was calibrated to stage and discharge measurements at flows of 276.7, 134.4, 60.2 and 17.1 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 45 and 90 cfs, respectively (Figure 29). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 45 cfs is recommended for the low flow period from July 1 through March 31.

Timber cutting and road placement in the riparian zone combined with frequent rain or snow events in the high elevation headwaters, have resulted in poor channel stability in the lower reaches of Keeler Creek. The recommended flow provides optimal riffle coverage for the present channel conditions and may be considerably higher than typical basal flows.

An average depth of 0.5 ft, minimum depth requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 15 cfs (Table 42). At the recommended flow of 45 cfs, water depth at the shallowest transect is sufficient for the successful passage of migrant fish, and consequently a specific passage flow is not requested.

Table 41. The results of a two-pass population evaluation of bull trout and eastern brook trout $\geq$75 mm in Keeler Creek (NE 1/4, Sec. 19, T30N, R33W) during August 1987. Discharge 17.1 cfs.

	DV	EBT
Fish captured in sample section	11	11
Fish estimated in sample section	12 $\pm$ 1	16 $\pm$ 8
Fish estimated per kilometer	75 $\pm$ 6	100 $\pm$ 50
Fish estimated per acre	28 $\pm$ 2	38 $\pm$ 19
Average length of fish captured (mm)	94	122

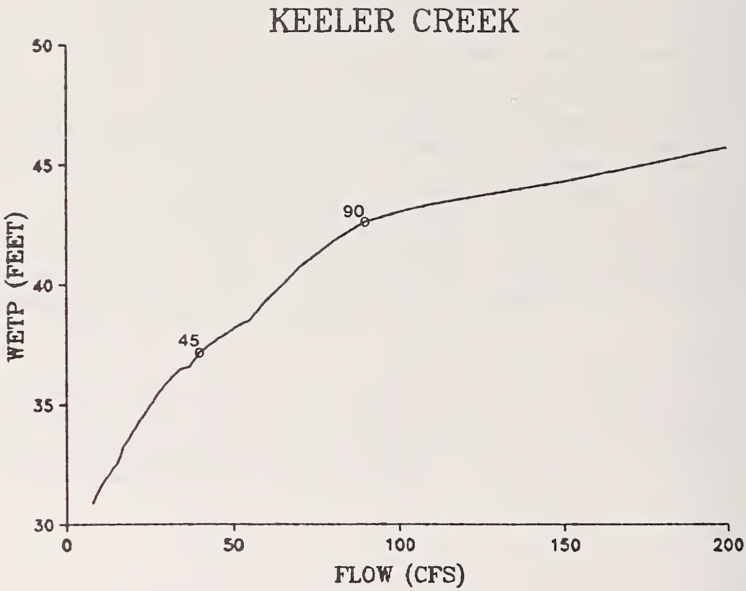

Figure 29. The wetted perimeter-discharge relationship for five riffle transects on Keeler Creek, 1987.

Table 42. The average depths in five riffle cross sections on Keeler Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
15	.64	.64	.61	.51	.59
45	.95	.87	.92	.76	.82
90	1.00	1.03	1.06	1.05	1.06

Yaak River Subdrainage

Spawning migrations from, and recruitment to, the Kootenai River are restricted to the lower 14.4 km of the Yaak River below Yaak Falls. This subdrainage received the most interest in the Kootenai basin for hydropower development. The main stem Yaak River above and below the falls was researched by May (1982) and later reanalyzed with the updated WETP program by Marotz and Fraley (1986). Primary forks and tributaries of the Yaak subdrainage contain a substantial resident fishery. Results of the wetted perimeter investigation on seven streams in the Yaak drainage are presented here.

SEVENTEENMILE CREEK

Description

Stream reach: Seventeenmile Creek from its junction with Yaak River (Sec. 27, T34N, R33W), to its headwaters (Sec. 7, T34N, R33W) (Figure 30).

Stream length: 25.6 km. Total drainage area: 154 km^2. Gradient: 16.7 m per km.

Source and Land Use

Seventeenmile Creek originates on the northwest face of O'Brien Mountain (2,064 m, 6,772 ft). It flows into the Yaak River at 792 m (2,598 ft) elevation as a fourth-order stream with contributions from 15 named first-, second-, and third-order streams. The U.S. Forest Service is the primary landowner, holding 99 percent of the drainage. Private ownership is concentrated along the stream corridor of the lower drainage. Timber production is the primary land use in the drainage. Grazing and residential uses are also important in the lower drainage, and recreational use is important throughout the basin.

A road follows the stream for its entire length providing easy access. Restrictions exist in the form of some steep areas and private property along five km of stream side.

Continued timber harvest and roads have the potential to increase both sediment loading and the occurrence of damaging peak flow events.

Flows

Few flow measurements have been obtained on Seventeenmile Creek except for sporadic records by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 72.8 cfs.

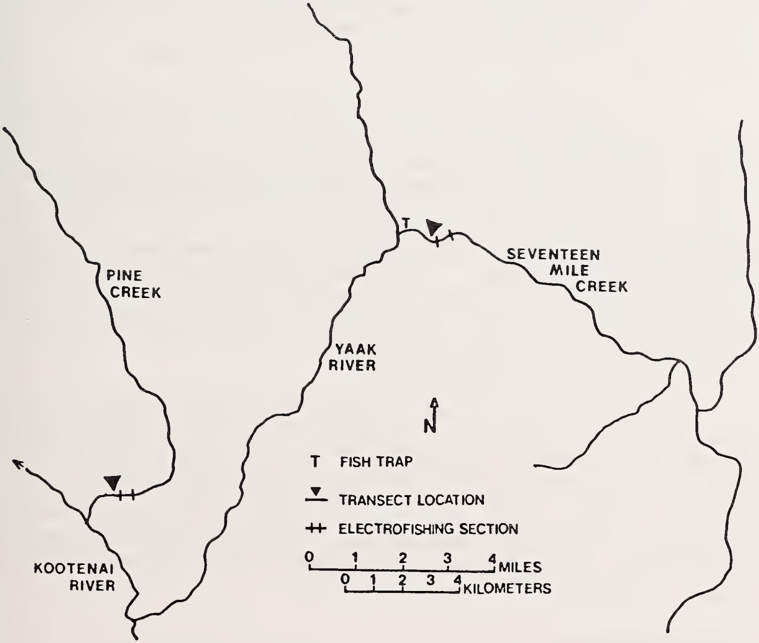

Figure 30. The relative location of Seventeenmile and Pine creeks.

Fish Populations

Resident and Pre-emigrant Fish

A population estimate was obtained on September 16, by a three-pass application of the removal method using bank shocking equipment (Table 43). A 165-m section was chosen that was located one km upstream of Forest Road 176 bridge (SW 1/4, Sec. 26, T34N, R33W). Average stream width in the sampled section was 10.4 m, and the discharge at the time of sampling was 7.5 cfs. A length-frequency histogram is provided (Appendix B27).

Migrant Fish

In an attempt to assess the extent to which Seventeenmile Creek serves as a spawning tributary to the Yaak River, an upstream migrant trap was placed near the mouth of Seventeenmile Creek on April 24. High spring discharges greatly hampered the effort. Trap leads could not be maintained for more than one-half day; and after the first week of operation, large logs and debris washed over the trap, preventing further sampling until the high discharge subsided. After removing the debris jam with a chain saw, and repairing the trap, sampling was resumed on May 19. From that date until June 17, 35 rainbow trout of 234 mm average length were captured while migrating into Seventeenmile Creek. Three of those fish exceeded 450 mm.

On June 25, a downstream migrant trap was installed. From that date until August 30, 26 rainbow, 3 cutthroat, and 3 brook trout, and 20 mountain whitefish were captured. None of these fish had been previously marked during the upstream migration, and few were large enough to be of spawning maturation. It is therefore assumed that these out-migrants were recruits from Seventeenmile Creek and were enroute to the Yaak River. The small sample size and lack of recaptures precluded an estimate of the total spawning run.

Flow Recommendations

Five permanent transects were established in riffle areas in Seventeenmile Creek one km upstream from Forest Road 176 bridge (SW 1/4, Sec. 26, T34N, R33W). The WETP program was calibrated to stage and discharge measurements at flows of 86.6, 45.6, 17.1 and 7.5 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 16 and 40 cfs, respectively (Figure 31). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 40 cfs is recommended for all periods of the year.

The lower reaches of Seventeenmile Creek contain large substrate and the existing channel morphology probably reflects high discharge events. The recommended flow provides optimal

Table 43. The results of a three-pass population evaluation of rainbow trout ≥ 75 mm in Seventeenmile Creek (SW 1/4, Sec. 26, T34N, R33W) during September 1987. Discharge 7.5 cfs.

	RB
Fish captured in sample section	146
Fish estimated in sample section	162 $\pm$ 24
Fish estimated per kilometer	982 $\pm$ 148
Fish estimated per acre	385 $\pm$ 57
Average length of captured fish (mm)	102

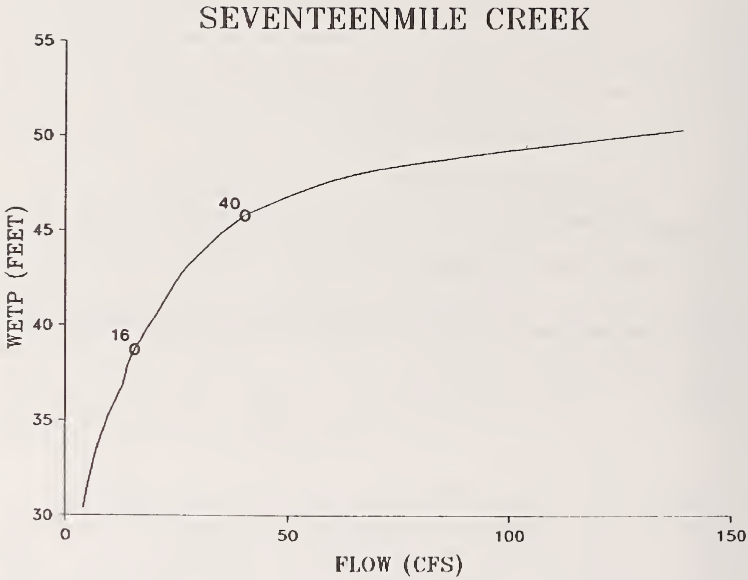

Figure 31. The wetted perimeter-discharge relationship for five riffle transects on Seventeenmile Creek, 1987.

riffle coverage for the present channel conditions and may be considerably higher than typical basal flows.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 17 cfs (Table 44). At the recommended flow of 40 cfs, water depth at the shallowest transect is sufficient for the successful passage of migrant fish, and consequently a specific passage flow is not requested.

Table 44. The average depths in five riffle cross sections on Seventeenmile Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
16	.49	.54	.52	.78	.51
17	.50	.56	.52	.79	.52
40	.64	.72	.61	.89	.76

SPREAD CREEK

Description

Stream reach: Spread Creek from its junction with Yaak River (Sec. 10, T35N, R33W) to the headwaters (Sec. 34, T37N, R34W) (Figure 32).

Stream length: 19.9 km. Total drainage area: 96.6 km^2. Gradient (from junction with Hidden Creek): 35 m per km.

Source and Land Use

Spread Creek originates on the southeast face of Canuck Peak (2,113 m, 6,934 ft) and joins the Yaak River at 878 m (2,881 ft). Spread Creek is a high energy stream characterized by substantial bedload movement and a boulder-strewn substrate. The entire drainage is held by the U.S. Forest Service.

Flows

The mean annual discharge of Spread Creek is 80.5 cfs (Parrett and Hull, 1985). An estimated annual hydrograph taken from the same source is given in Figure 33.

Potential Environmental Problems

There is great potential for hydroelectric development and associated environmental impacts in Spread Creek. Interest has been shown in the past, specifically in 1984 when an application for a hydroelectric project was made to FERC, but was surrendered later in the same year.

Timber production and roads have the potential to increase sediment loading, and magnify peak flow events to the detriment of the fishery.

Fish Populations

A population estimate was obtained on September 3, by a two-pass application of the removal method using bank shocking equipment. A 162-m section was chosen immediately above the Yaak River Road (SW 1/4, Sec. 3, T35N, R33W). Game fish were composed of cutthroat, rainbow and brook trout (Table 45). Of the *Salmo* spp. captured, roughly two-thirds were cutthroat and one-third rainbow trout. Longnose dace were observed to be common, and sculpins were present, but uncommon. The average width of the stream in the sampled section was 10.7 m, and the discharge at the time of sampling was 20 cfs. A length-frequency histogram of rainbow trout captures is provided (Appendix B28).

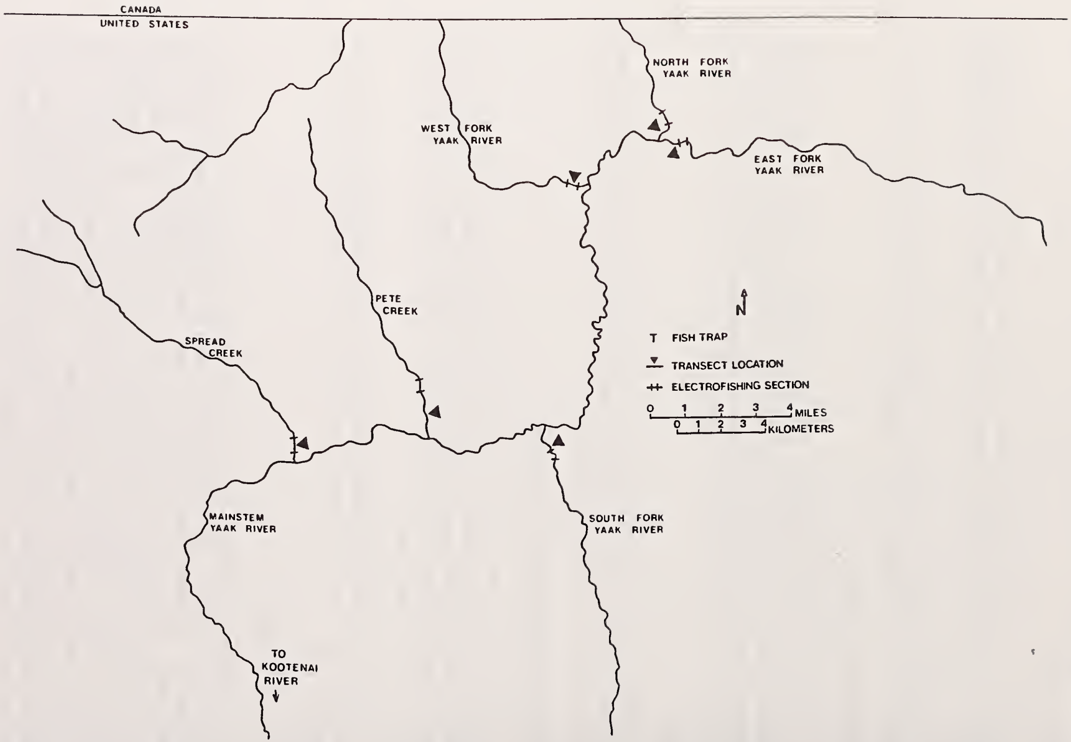

Figure 32. The Yaak River subdrainage.

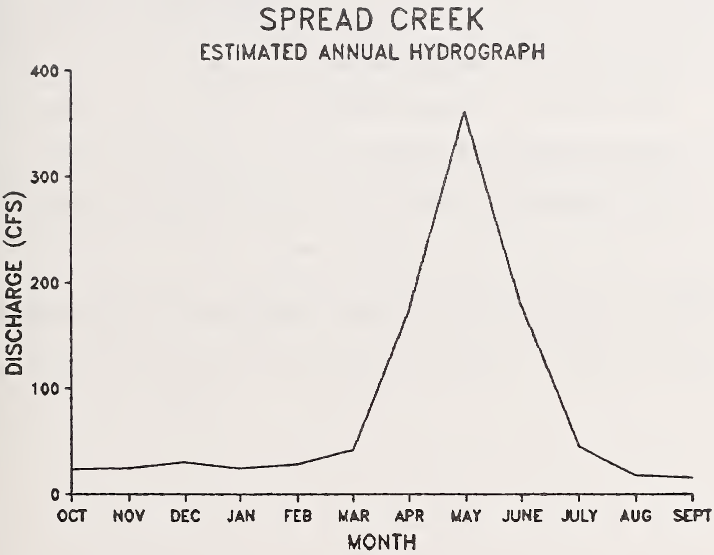

Figure 33. An estimated annual hydrograph for Spread Creek (USGS).

Table 45. The results of a two-pass population evaluation of fish ≥ 75 mm in Spread Creek (SW 1/4, Sec. 3, T35N, R33W) during September 1987. Discharge 20 cfs.

	Salmo spp.	EBT
Fish captured in sample section	46	8
Fish estimated in sample section	60 ± 24	60 ± 4
Fish estimated per kilometer	370 ± 148	56 ± 25
Fish estimated per acre	141 ± 56	21 ± 9
Average length of fish captured (mm)	110	119

Flow Recommendations

Five permanent transects were established in riffle areas in Spread Creek immediately above Yaak Road 92 bridge (NE 1/4, Sec. 10, T35N, R33W). The WETP program was calibrated to stage and discharge measurements at flows of 133.3, 75.4 and 19.1 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 18 and 50 cfs, respectively (Figure 34). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 50 cfs is recommended for all periods of the year.

The lower reaches of Spread Creek contain large substrate and the existing channel morphology probably reflects high discharge events. The recommended flow provides optimal riffle coverage for the present channel conditions and may be considerably higher than typical basal flows.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish is not reached in all transects until the flow equals or exceeds 28 cfs (Table 46). At the flow recommendation of 50 cfs, water depth at the shallowest transect is sufficient for successful migration of fish, and consequently a specific passage flow is not requested.

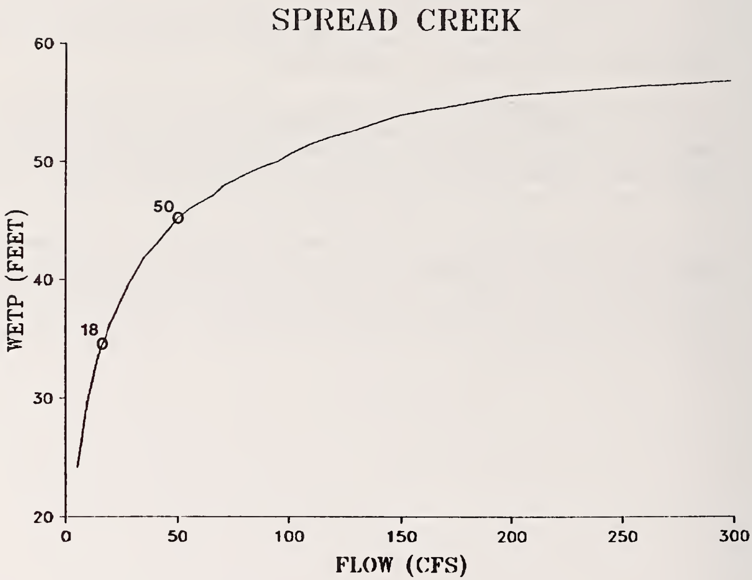

Figure 34. The wetted perimeter-discharge relationship for five riffle transects on Spread Creek, 1987.

Table 46. The average depths in five riffle cross sections on Spread Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
18	.39	.46	.56	.75	.70
28	.50	.52	.60	.89	.84
50	.64	.69	.72	1.11	.96

PETE CREEK

Description

Stream reach: Pete Creek from its junction with Yaak River (NW 1/4, Sec. 5, T30N, R32W) to the headwaters (Sec. 24, T37N, R33W) (Figure 32).

Stream length: 18 km. Total drainage area: 87.5 km^2. Gradient: 23 m per km.

Source and Land Use

Pete Creek has three named tributaries. The headwaters are at Pete Creek Meadows (Sec. 24, T37N, R33W). The highest point in the drainage is Black Top Mountain at 1,979 m (6,492 ft) elevation. Pete Creek joins the Yaak River at 890 m (2,120 ft) elevation. The entire Pete Creek drainage is owned by the U.S. Forest Service and is used primarily for timber production and recreation. Stream access, as provided by publicly owned lands and Forest Road 338, is excellent.

Flows

The mean annual discharge of Pete Creek is 39.4 cfs (Parrett and Hull, 1985) An estimated annual hydrograph taken from the same source is given in Figure 35.

Potential Environmental Problems

Timber harvest and roads in the drainage have the potential to increase sediment loading and magnify peak flow events to the detriment of the fishery.

Fish Populations

Pete Creek provides a popular resident fishery and also provides outstanding spawning and recruitment to the Yaak River. In 1987, the U.S. Forest Service replaced the culvert under Forest Road 338 which formerly had blocked passage to over 15 km of spawning habitat upstream.

A population estimate was obtained on September 2, by a two-pass application of the removal method, using backpack electroshocking gear. A section was chosen that began at the Forest Road 338 culvert and extended 152 m downstream (SW 1/4, Sec. 29, T36N, R32W). The results of the population evaluation of fish $\geq$75 mm are given in Table 47. The average width of the stream in the sampled section was 5.5 m, and the discharge at the time of sampling was 2.7 cfs. A length-frequency histogram for eastern brook trout is given (Appendix B29).

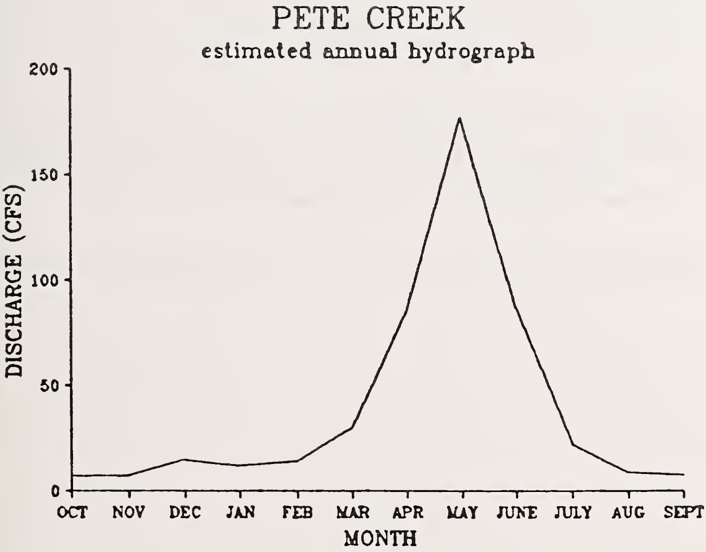

Figure 35. An estimated annual hydrograph for Pete Creek (USGS).

Table 47. The results of a two-pass population evaluation of westslope cutthroat and eastern brook trout ≥75 mm in Pete Creek (SW 1/4, Sec. 29, T36N, R32W) during September 1987. Discharge 2.7 cfs.

	EBT	WCT
Fish captured in sample section	81	10
Fish estimated in sample section	82 ± 3	12 ± 8
Fish estimated per kilometer	539 ± 20	80 ± 53
Fish estimated per acre	397 ± 5	58 ± 39
Average length of fish captured (mm)	120	119

Flow Recommendations

Five permanent transects were established in riffle areas in a 100-m section of Pete Creek located 0.5 km upstream from Yaak Road bridge (NW 1/4, Sec. 5, T36N, R32W). The WETP program was calibrated to stage and discharge measurements at flows of 43.9, 20.1 and 2.7 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 6 and 15 cfs, respectively (Figure 36). Based on existing fish populations, results of the wetted perimeter analysis, and estimated water availability, a flow of 15 cfs is recommended for the period from July 1 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not continually reached in all transects until the flow equals or exceeds 20 cfs (Table 48). Therefore a passage flow of 20 cfs is requested from April 1 through June 30.

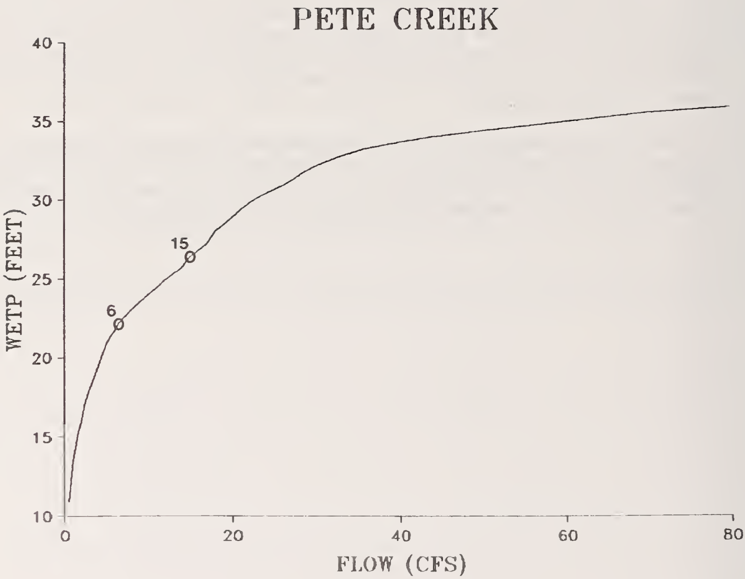

Figure 36. The wetted perimeter-discharge relationship for five riffle transects on Pete Creek, 1987.

Table 48. The average depths in five riffle cross sections on Pete Creek at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
6	.61	.32	.38	.58	.38
15	.72	.52	.51	.79	.50
20	.76	.57	.56	.85	.50

SOUTH FORK YAAK RIVER

Description

Stream reach: South Fork Yaak River from its junction with main stem Yaak River (SW 1/4, Sec. 35, T36N, R31W) to the headwaters (Sec. 30, T34N, R31W) (Figure 32).

Stream length: 16.9 km. Total drainage area: 156.0 km^2. Gradient: 11.7 m per km.

Source and Land Use

The South Fork Yaak River originates on the north slope of Flatiron Mountain (1,796 m, 5,891 ft) and flows north to the Yaak River joining it at 899 m (2,949 ft) elevation. The upper reaches are characterized by a meandering channel pattern with frequent still pools and beaver impoundments. The lower reaches are a higher gradient, canyon with boulder strewn substrate. Private individuals own approximately 2.5 percent of the drainage, Champion International Corporation owns 0.5 percent, and the remainder is held by the U.S. Forest Service. Timber production, grazing, and recreation are the primary land uses in the drainage.

Flows

Few flow data have been obtained on South Fork Yaak River except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 69.4 cfs.

Potential Environmental Problems

Timber harvest and roads have the potential to increase sediment loading and magnify peak flow events to the detriment of the fishery.

Fish Populations

A population estimate was obtained on August 13, by the mark-recapture method using bank shocking equipment. The recapture run was made on August 20. A 244-m section about one km upstream from the mouth was chosen for its location between physical stream features thought to discourage fish passage (SW 1/4, Sec. 1, T35N, R31W). Game fish consisted of brook and rainbow trout, with the former more common (Table 49). Longnose dace were observed to be abundant and sculpins were considered rare. Young-of-the-year mountain whitefish were common. Average stream width in the sampled section was 9 m and the discharge at the time of sampling was 9.2 cfs. A length-frequency histogram for rainbow trout is given (Appendix B30).

Table 49. The results of a two-pass population evaluation of eastern brook trout and rainbow trout ≥75 mm in the South Fork Yaak River (SW 1/4, Sec. 1, T35N, R31W) during August 1987. Discharge 9.2 cfs.

	EBT	RB
Fish captured in sample section	43	34
Fish estimated in sample section	98 ± 52	55 ± 23
Fish estimated per kilometer	401 ± 213	225 ± 94
Fish estimated per acre	178 ± 94	100 ± 42
Average length of fish captured (mm)	124	126

Flow Recommendations

Five permanent transects were established in riffle areas in South Fork Yaak River from about one km upstream from the confluence with Yaak River (NW 1/4, Sec. 1, T36N, R31W). The WETP program was calibrated to stage and discharge measurements at flows of 48.4, 29.8, 9.2 and 7.0 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 9.0 and 19.0 cfs, respectively (Figure 37). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 19 cfs is recommended for the low flow period from July 1 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish is not reached in all transects until the flow equals or exceeds 23 cfs (Table 50). A passage flow of 23 cfs is therefore recommended from April 1 through June 30 to ensure successful migration of fish during the spring spawning run.

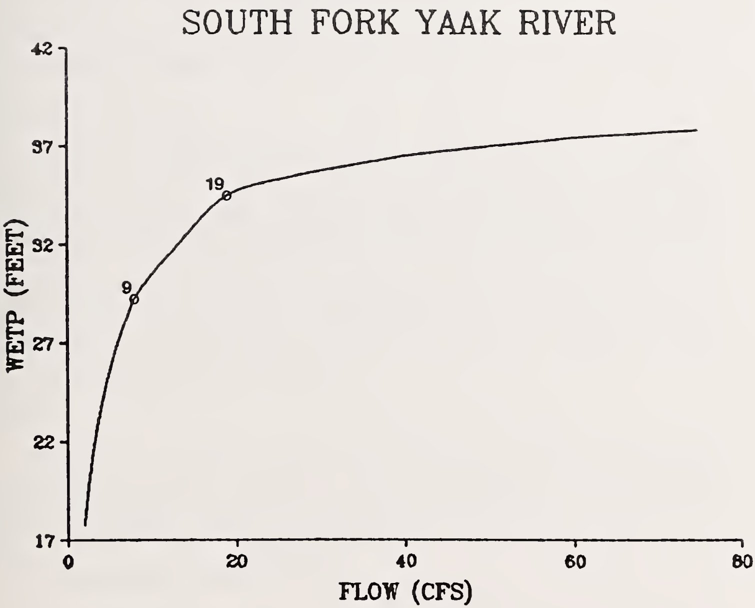

Figure 37. The wetted perimeter-discharge relationship for five riffle transects in South Fork Yaak River, 1987.

Table 50. The average depths in five riffle cross sections on South Fork Yaak River at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
9	.43	.38	.35	.46	.36
19	.60	.51	.46	.60	.47
23	.66	.55	.50	.64	.52

WEST FORK YAAK RIVER

Description

Stream reach: West Fork Yaak River from the junction with main stem Yaak River (SE 1/4, Sec. 32, T36N, R31W) to its source (Sec. 19, T37N, R33W) (Figure 32).

Stream length: 34.3 km. Total drainage area: 285.6 km^2. Gradient: 24.9 m per km.

Source and Land Use

West Fork Yaak River originates in the Northwest Peak Scenic Area (Sec. 1, T36N, R33W) in which Northwest Peak is the highest point at 2,348 m (7,705 ft) elevation. Part of the drainage (36 percent), 6.4 km of the stream course, is in Canada. The West Fork joins the main stem Yaak River at 1,305 m (4,281 ft) elevation, where private individuals and Champion International Corporation own less than one percent of the drainage area. The remainder of the drainage is managed by the U.S. Forest Service. The stream channel is characterized by a large, bouldery substrate. An observation area was developed at a falls located 1.5 km upstream from the mouth.

Flows

Few flow data have been obtained on West Fork Yaak River except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 185 cfs.

Potential Environmental Problems

Timber harvest and roads have the potential to increase sediment loading and magnify peak flow events to the detriment of the fishery.

Fish Populations

A population estimate was obtained on September 22, by a two-pass application of the removal method using bank shocking equipment. A 166-m section was chosen about 100 m above the Yaak Road 92 bridge (NW 1/4, Sec. 32, T37N, R31W). Game fish were predominantly cutthroat trout, and brook trout were second in abundance (Table 51). Sculpins were commonly observed while electrofishing.

A length-frequency histogram for westslope cutthroat trout is given (Appendix B31). Average stream width in the sampled section was 9.1 m, and the discharge at the time of sampling was 7.0 cfs.

Table 51. The results of a two-pass population evaluation of westslope cutthroat and eastern brook trout $\geq$75 mm in the West Fork Yaak River (NW 1/4, Sec. 32, T37N, R31W) during September 1987. Discharge 7.0 cfs.

	WCT	EBT
Fish captured in sample section	23	11
Fish estimated in sample section	26 $\pm$ 8	13 $\pm$ 6
Fish estimated per kilometer	156 $\pm$ 48	78 $\pm$ 36
Fish estimated per acre	69 $\pm$ 21	35 $\pm$ 16
Average length of fish captured (mm)	117	177

Flow Recommendations

Five permanent transects were established in riffle areas in West Fork Yaak River from 100 m upstream of the Yaak Road 92 bridge (NW 1/4, Sec. 32, T37N, R31W). The WETP program was calibrated to stage and discharge measurements at flows of 120.4, 71.7 and 8.9 cfs. Lower and upper inflection points in a plot of the wetted perimeter-discharge relationship occur at 10 and 30 cfs, respectively (Figure 38). Based on existing fish populations and results of the wetted perimeter analysis, a flow of 30 cfs is recommended for all periods of the year.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish is not reached in all transects until the flow equals or exceeds 20 cfs (Table 52). At the recommended flow of 30 cfs, water depth at the shallowest transect is sufficient for successful passage of migrant fish. Consequently, a specific passage flow is not requested.

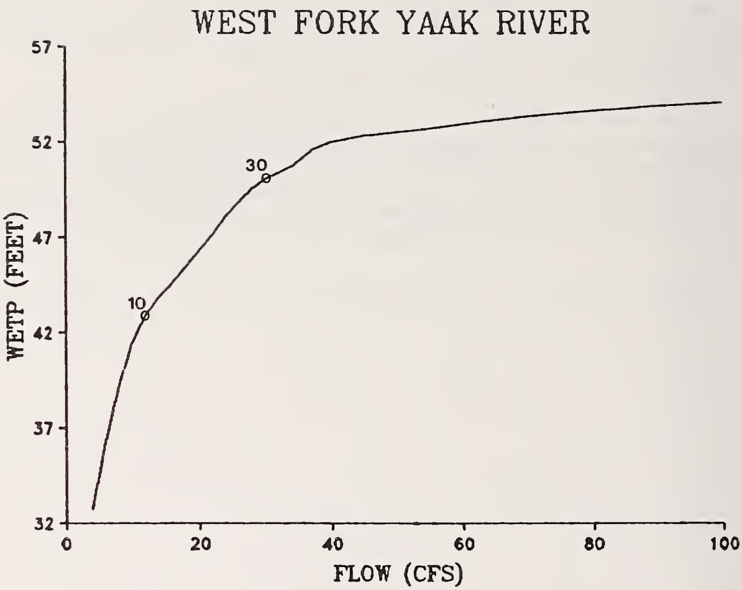

Figure 38. The wetted perimeter-discharge relationship for five riffle transects on West Fork Yaak River, 1987.

Table 52. The average depths in five riffle cross sections on West Fork Yaak River at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
10	.43	.42	.38	.44	.54
20	.54	.54	.50	.57	.70
30	.59	.64	.59	.65	.75

EAST FORK YAAK RIVER

Description

Stream reach: East Fork Yaak River from the confluence with North Fork Yaak River (SE 1/4, Sec. 22, T37N, R31W) to the headwaters (Sec. 9, T36N, R29W) (Figure 32).

Stream length: 23.5 km. Total drainage area: 249 km^2. Gradient (last 17 km): 17.8 m per km.

Source and Land Use

East Fork Yaak River originates on Red Mountain (2,011 m, 6,599 ft) and flows west to its confluence with North Fork Yaak River. Three percent of the drainage extends into Canada. The U.S. Forest Service holds the vast majority of the drainage, with minor holdings by Champion International Corporation (<1 percent) and private individuals (2 percent). Timber production and recreation are the primary land uses.

Flows

Few flow measurements have been obtained on East Fork Yaak River except for sporadic records by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 86.6 cfs.

Potential Environmental Problems

Timber harvest and roads have the potential to increase sediment loading and peak flow events which may degrade channel stability and fish habitat.

Fish Populations

A population estimate was obtained on August 27, by a two-pass application of the removal method using bank electroshocking equipment. A 152-m section was chosen that was located 0.5 km upstream from the junction with North Fork Yaak River (SW 1/4, Sec. 23, T37N, R31W). Game fish consisted of rainbow and brook trout (Table 53) and mountain whitefish. Sculpins were observed to be abundant and dace present.

The low population estimate may not truly represent the population throughout East Fork Yaak River for the following reasons: 1) the sampled section was immediately above a bridge crossing suggesting that fishing pressure may be high, and 2) a bedrock pool complex 40 ft in length reduced electrofishing capture efficiency. Average stream width in the sampled section was 10.4 m, and discharge at the time of sampling was 29.8 cfs.

Table 53. The results of a two-pass population evaluation of rainbow and eastern brook trout in the East Fork Yaak River (SE 1/4, Sec. 23, T37N, R31W) during August 1987. Discharge 29.8 cfs.

	RB	EBT
Fish captured in sample section	12	14
Fish estimated in sample section	13 ± 5	17 ± 8
Fish estimated per kilometer	86 ± 33	112 ± 53
Fish estimated per acre	33 ± 13	44 ± 20
Average length of fish captured	113	95

Flow Recommendations

Five permanent transects were established in riffle areas in East Fork Yaak River in a 0.25 km stream section immediately upstream from the junction with North Fork Yaak River (SW 1/4, Sec. 23, T37N, R31W). The WETP program was calibrated to stage and discharge measurements at flows of 137.6, 60.8, 29.8 and 15.3 cfs. An inflection point in a plot of the wetted perimeter-discharge relationship occurs at 14 cfs, (Figure 39). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 14 cfs is recommended for the low flow period from July 1 through March 31.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 27 cfs (Table 54). A passage flow of 27 cfs is therefore recommended from April 1 through June 30 to ensure successful migration of fish during the spring spawning run.

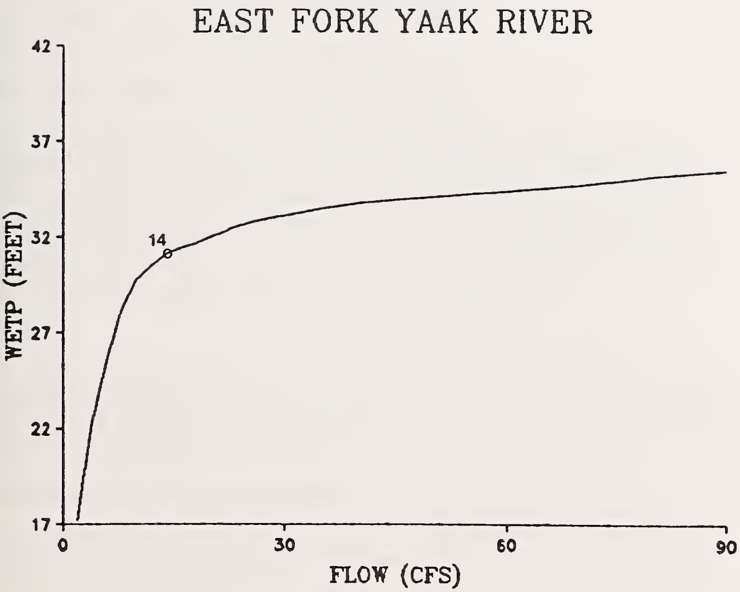

Figure 39. The wetted perimeter-discharge relationship for five riffle transects on East Fork Yaak River, 1987.

Table 54. The average depths in five riffle cross sections on East Fork Yaak River at selected flows of interest.

Flow	Average Depth (ft)				
	CS1	CS2	CS3	CS4	CS5
14	.33	.44	.38	.45	.39
27	.50	.62	.56	.63	.56

NORTH FORK YAAK RIVER

Description

Stream reach: North Fork Yaak River from the junction with East Fork Yaak River (SE 1/4, Sec. 22, T37N, R31W) to the Canadian border (NE 1/4, Sec. 4, T37N, R31W) (Figure 32).

Stream length: 34 km. Total drainage area: 388 km^2. Gradient: 12.4 m per km.

Source and Land Use

North Fork Yaak River originates in Canada; eleven percent of the drainage lies within the United States. Of the American portion, private individuals own six percent and Champion International Corporation owns one percent, all of which is in the valley bottom including the riparian zone. The remaining 93 percent is held by the U.S. Forest Service. Timber production, grazing and recreation are the primary land uses in the drainage. The stream is easily accessible by road.

Flows

Few flow data have been obtained on North Fork Yaak River except for sporadic measurements by personnel of the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks. Estimated mean annual discharge is 202 cfs.

Potential Environmental Problems

Timber harvest and roads in the drainage have the potential to increase sediment loading and magnify peak flow events to the detriment of the fishery.

Fish Populations

A population estimate was obtained on September 23, by a three-pass application of the removal method using drift electroshocking equipment. A 183-m section was chosen about 75 m above the Yaak Road 92 bridge (NE 1/4, Sec. 22, T37N, R31W). Game fish were composed of both brook and rainbow trout (Table 55). Mountain whitefish, sculpins and suckers were all observed during electrofishing. Average stream width in the sampled section was 13.7 m, and the discharge at the time of sampling was 12 cfs. Length-frequency histograms of rainbow and eastern brook trout are provided in Appendix B32 and B33, respectively.

Flow Recommendations

Five permanent transects were established in riffle areas in North Fork Yaak River about 0.5 km upstream from Yaak Road bridge Table 55.

Table 55. The results of a three-pass population evaluation of eastern brook and rainbow trout in the North Fork Yaak River (NE 1/4, Sec. 22, T37N, R31W) during September 1987. Discharge 12 cfs.

	EBT	RB
Fish captured in sample section	174	108
Fish estimated in sample section	184 $\pm$ 7	121 $\pm$ 14
Fish estimated per kilometer	1060 $\pm$ 38	661 $\pm$ 77
Fish estimated per acre	313 $\pm$ 11	195 $\pm$ 23
Average length of fish captured (mm)	102	129

(SW 1/4, Sec. 23, T37N, R31W). A beaver dam raised water levels at transect number one making measurements there invalid. The WETP program was calibrated to stage and discharge measurements at flows of 141.7, 63.7 and 13.1 cfs. Inflection points in a plot of the wetted perimeter-discharge relationship occur at 14 and 50 cfs (Figure 40). Based on existing fish populations, and results of the wetted perimeter analysis, a flow of 50 cfs is recommended for all periods of the year.

The lower reaches of the North Fork Yaak River contain small substrate originating from a glacial outwash plain. Beaver activity in the sampling reach limited choices for transect locations. An obvious inflection point occurs at 90 cfs which is substantially higher than typical basal flows. For this reason, a secondary inflection at 50 cfs was chosen. This recommended flow provides adequate riffle coverage for existing channel conditions and may be higher than basal flows during some portions of certain water years.

An average depth of 0.5 ft, minimum requirement for passage of migrant fish, is not reached in all transects until the flow equals or exceeds 30 cfs (Table 56). At the recommended flow of 50 cfs, water depth at the shallowest transect is sufficient for successful passage of migrant fish, and consequently a specific passage flow is not requested.

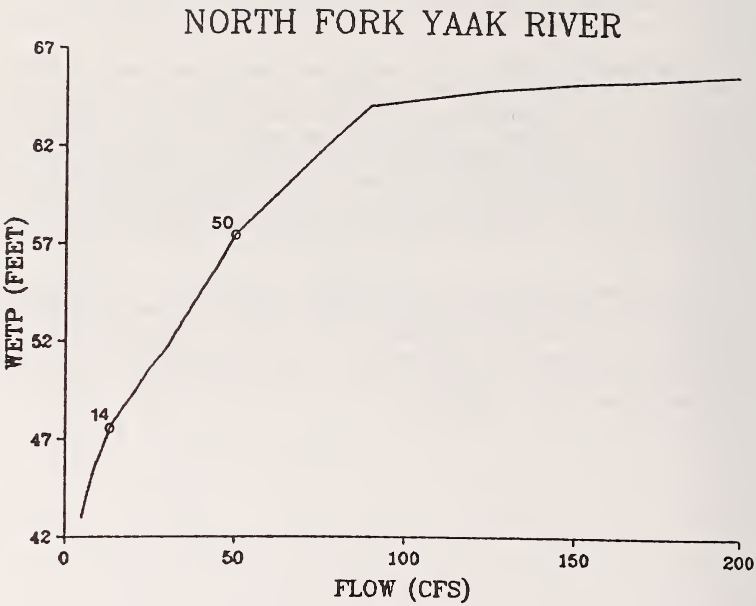

Figure 40. The wetted perimeter-discharge relationship for four riffle transects on North Fork Yaak River, 1987.

Table 56. The average depths in four riffle cross sections on North Fork Yaak River at selected flows of interest.

Flow	Average Depth (ft)			
	CS2	CS3	CS4	CS5
14	.42	.43	.65	.70
30	.50	.54	.78	.84
50	.56	.62	.84	.82

Migrant Bull Trout in Quartz Creek

Migratory bull trout were trapped in Quartz Creek to document and describe the population that spawns there. The information obtained includes: 1) an estimation of the 1986 and 1987 spawning runs in Quartz Creek, 2) the time frame in which bull trout enter, reside in, and exit the spawning stream, 3) the length distribution of the population, 4) growth rates and the frequency that individuals spawn, 5) an estimate of spawning-related mortality, and 6) movements of four adults after they returned to the Kootenai River.

Two traps were placed in Quartz Creek in 1986 and 1987 one km upstream from the mouth. The traps were positioned side by side, one facing upstream and one facing downstream. "X"-shaped leads of one-inch poultry mesh were positioned to funnel fish into the openings of the traps (Figure 2). Lead heights above water surface averaged 0.45 m (18 in) in 1986, and 0.75 m (30 in) in 1987. Water depths along the leads ranged from negligible to 0.35 m. Two fish in 1986 and one in 1987 were captured in the area between the upstream and the downstream leads.

1986 TRAPPING

Twenty-three adult bull trout were captured, fin-clipped and tagged after entering Quartz Creek between May 31 and September 25. We were unable to capture any fish leaving Quartz Creek. The trapping effort was abandoned in November after ice buildup became too severe. On several occasions prior to November, accumulations of leaves caused the leads to fall, possibly allowing escapement of fish in the stream. Two fish of the 1986 spawning run were caught by fishermen in the Kootenai River in the winter of 1987. See Figure 41 for the length distribution of fish in the 1986 spawning run.

1987 TRAPPING

Twenty adult bull trout were captured and tagged after entering Quartz Creek. Only one of these had been captured in 1986, and it entered the stream 14 days later in 1987 than it had in 1986. Although none of these 20 fish were caught in the out-migrant trap, the majority, if not all, were seen on October 3 in a single pool upstream of the trap, their downstream movement impeded by the out-migrant leads. It is unknown whether the fish were unwilling to enter the trap, or if the trap failed to retain them due to low water velocities. By wearing a wet suit, snorkel, and mask, it was possible to approach the bull trout while they lay in cover, and 17 were individually netted from the pool; an unknown number escaped capture. Ten of these were tagged, three

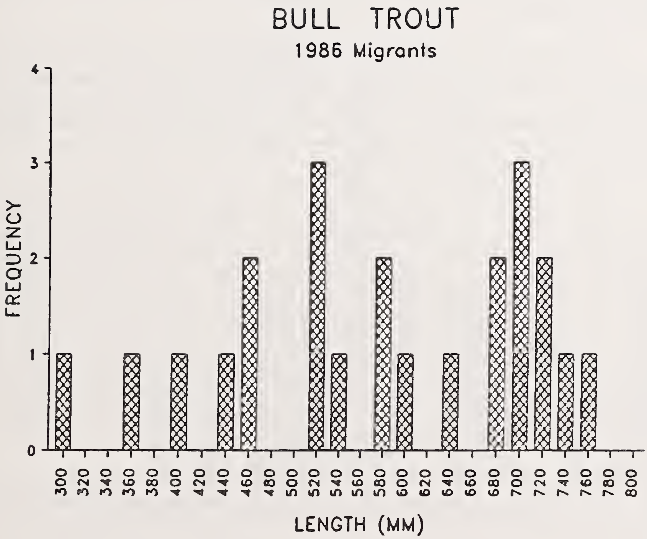

Figure 41. The length distribution of migrant bull trout in Quartz Creek in 1986.

were identified as having lost their tags, and four were unmarked. Two of the tagged fish had been previously captured in 1986, bringing the total to three adults which migrated into Quartz Creek during 1986 and 1987. Estimation of the total spawning run by the mark-recapture method indicates 31 $\pm$ 6 spawners entered Quartz Creek in 1987. The capture efficiency of in-migrants was only about 63 percent, 11 marked fish in the 17 out-migrants captured. See Figure 42 for the length distribution of fish in the 1987 spawning run.

In December 1987, two fish tags from the 1987 group were returned by fishermen. One of these fish was caught in the Kootenai River about 40 km upstream from Quartz Creek. The other had moved downstream in the river about 80 km, over Kootenai Falls, and was found dead about about 100 m upstream from the mouth in Mission Creek, Idaho.

Figures 43 and 44 illustrate the dates in 1986 and 1987 that each bull trout was captured as it entered Quartz Creek. Of interest is the extended period of time over which the fish entered the spawning stream. In 1986 the entry period spanned 78 days (or 117 days if the two captures on May 31, 300 and 360 mm, are considered spawning adults). In 1987 immigration lasted at least 78 days. Bull trout moved into Quartz Creek an average of 25 days earlier in 1987 (July 26) than in 1986 (August 20). Bull trout averaged 66 days in Quartz Creek during the spawning period (range 18 to 82 days), based on the 11 fish which were caught both entering and leaving Quartz Creek.

Bull trout redds were surveyed in Quartz Creek on October 13th and 15th. Locations of individual redds are given in Figure 45. The middle reaches of the stream received nearly all the spawning use, and the west fork was more heavily utilized than the main stem. Of the 35 redds enumerated, 20 were identified as definite, and 15 as probable. A comparison of the estimated 31 spawners in 1987 to the number of redds (20 definite and 15 probable) yields a ratio of 1.1 redds per spawner. Sixty percent of the 1987 migrants were female. If both the population estimate and redd counts are accurate, each female spawner excavated approximately two redds.

Of the 20 fish known to have entered the stream in 1987, only 11 were recaptured. The remaining nine fish either died, or survived spawning but escaped capture. Mortality therefore could range from zero to 45 percent, although the upper limit is undoubtedly high since some fish are known to have escaped capture.

The three fish captured in both trapping seasons provide useful information for determining annual growth rates, although the results are not highly accurate due to the small sample size

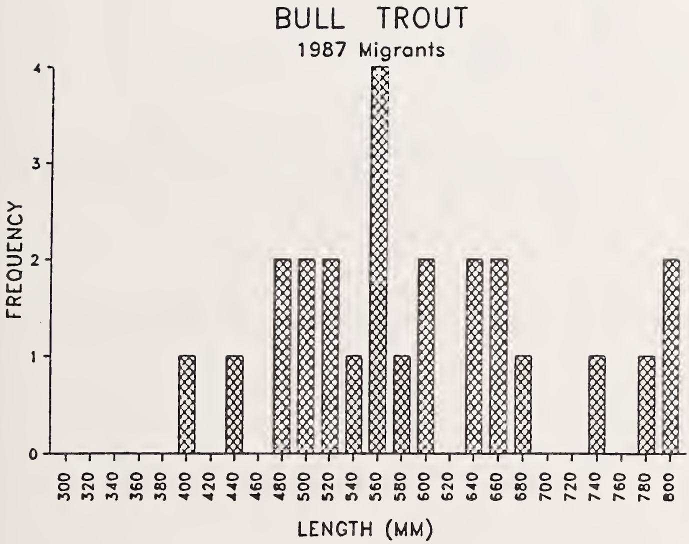

Figure 42. The length distribution of migrant bull trout in Quartz Creek in 1987.

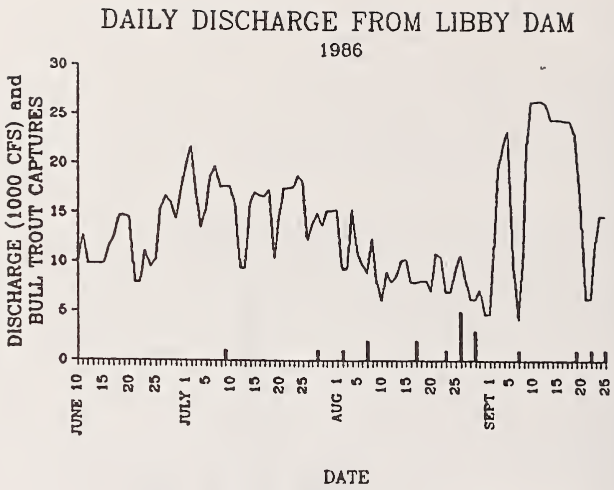

Figure 43. Timing of bull trout entry into Quartz Creek, 1986.

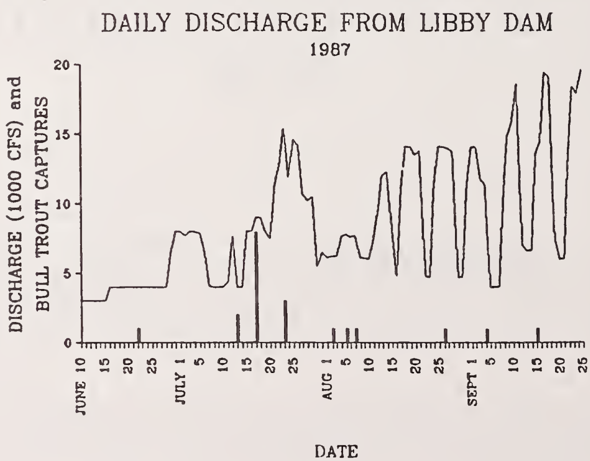

Figure 44. Timing of bull trout entry into Quartz Creek, 1987.

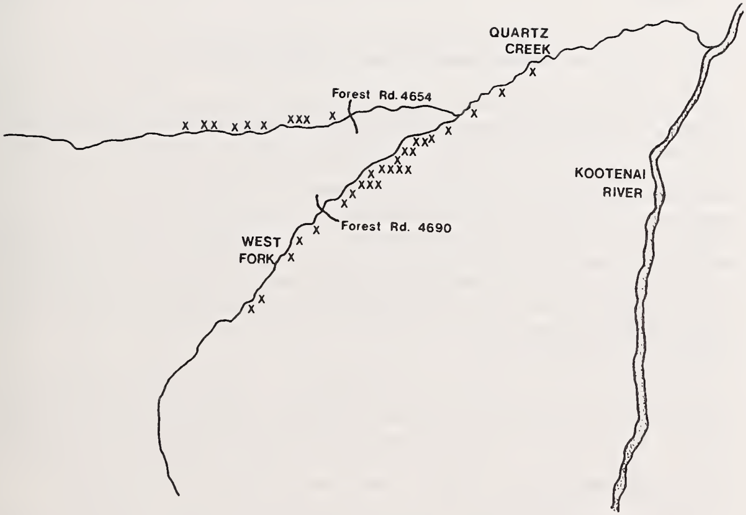

Figure 45. The locations of bull trout redds in Quartz Creek, 1987.

and difficulties in measuring large unanesthetized fish. Details of the change in length of these fish are:

Tag #	Length at	Date	Length at	Date	Growth
3866	725 mm	7/09/86	792 mm	07/23/87	67 mm
7507	695 mm	8/26/86	755 mm	10/14/87	60 mm
7518	740 mm	8/02/86	815 mm	10/07/87	75 mm

Delta Monitoring in Quartz Creek

Bedload materials are accumulating at the mouths of tributaries entering the Kootenai River below Libby Dam. Regulated reduction of peak flow events, which historically washed bedload materials away from the stream mouths, has allowed for substantial delta formation at Dunn, Libby, Pipe and Quartz creeks. Although migrant passage into these streams does not appear to be inhibited at present, continued deposition may eventually impede natural reproduction in some streams. Migrant bull trout may be especially sensitive because their fall spawning run coincides with low tributary flows and reduced distributary depths. Delta growth should be monitored and materials removed if passage is inhibited.

Since the construction of Libby Dam, three unusually large peak flow events have occurred in Quartz Creek (1974, 1978 and 1980). Each event brought increased bedload deposition to the Quartz Creek delta, raising concerns about passage of migrant trout from the Kootenai River into Quartz Creek for spawning.

The Northwest Power Planning Council's Fish and Wildlife Program (1982) Measure 804(d)(1) states "Bonneville shall fund the removal of materials which have accumulated in Kootenai River tributary deltas below Libby Dam as a result of the dam's construction and operation and which interfere with the migration of spawning fish." Monitoring of this problem was initiated in April 1987. Plots of the measurements taken are given in Appendix A10 through A17. Repetition of these measurements should be done after the next unusual peak flow event or by 1992.

Delta Passage

In conjunction with the monitoring of the quartz Creek delta, a stage discharge relationship was developed for the Kootenai River at the point where it is joined by Quartz Creek. Our objective was to determine the Kootenai River state to the timing of the bull trout migration into Quartz Creek. The concern was

that growth of the delta may eventually impede passage of migrants into Quartz Creek to spawn. To establish the relationship, the following measurements were taken:

Date	Discharge from Libby Dam (cfs)	Elevation (ft)
03/02/88	13,600	89.4
03/05/88	6,600	86.7
05/18/88	3,000	85.5

The correlation coefficient for the relationship between stage and discharge is 0.97 when log-transformed, and 0.99 when untransformed. Predictions of discharge are made with untransformed data since they correlate more closely with stage measurements. Additional discharge from contributing tributary streams was assumed to equal combined basal flow.

A cross section of the delta along the primary distributary reveals a level depositional area followed by a sharp drop at the delta terminus (Appendix A10). Quartz Creek forms a pool in the depositional zone and then cascades down coarse substrate before joining the river. The outermost portion of the delta forms a drop-off at an elevation of roughly 86 ft. Based on the stage discharge relationship, a dam discharge >4,050 cfs combined with basal flows from contributing tributary streams will be sufficient to inundate the present delta terminus (stage = 86 ft). It should be noted, however, that if tributary inflow was greater than basal flow during the stage-discharge calibration, estimates of dam discharge requirements may be underestimated.

The shallow, steep gradient zone at the delta terminus may act as a physical or behavioral barrier to fish passage. To test the barrier effect, daily river stage was plotted with the timing of the bull trout upstream migration during 1986 and 1987. Capture dates were reported as the day fish were removed from the trap; actual delta passage may have occurred a day or two prior to capture.

During the 1986 spawning season, river stage remained above 86 feet elevation, so presumably a barrier was not presented. However, assuming a day or two delay, the September migrants entered Quartz Creek during large increases in river level (Figures 43 and 44).

In 1987, the Libby Dam discharge was less than 4,050 cfs for much of June and July, and upstream migration very closely corresponded to increases in discharge. The bulk of the captures occurred in late July after river levels increased and the migrant pulses of July 13 and 17 immediately followed increases in river stage above 86 ft elevation.

Bull trout are known to migrate past shallow water and instream obstacles, so the existing Quartz Creek delta probably does not represent an impenetrable barrier at river stage below 86 ft. However, our data indicate that bull trout immigration to Quartz Creek corresponds with increased river stage (>4,050 cfs). The delta should be periodically monitored to determine if surface elevation is increasing.

RECOMMENDATIONS

Instream Flow

To maintain spawning and rearing potential in the study streams, instream flow recommendations resulting from the basin-wide investigation of the Kootenai watershed should be implemented by application to the DNRC. To facilitate consideration, flow recommendations should be filed in groups based on the degree of conflict, location and fishery information. This should be accomplished with minimum delay to secure a timely priority date and to balance fishery requirements with future water demands.

Basal flows in many of the study streams are typically lower than optimal for fish production as determined by the wetted perimeter method. Suboptimal flows may occur during portions of some water years, even without the effects of consumptive water uses. Existing water rights amount to more water than is naturally available on many of the study streams. It is not known, however, what percentage of existing claims are valid or currently in use. Cumulative effects of present water appropriations could degrade the fishery resource if water users exercise their rights to the fullest extent. Recommended flows were set at the level required to maintain present fish stocks in the Kootenai system. Water users with prior rights should be informed of potential dewatering problems and compliance with minimum flow requirements should be encouraged; no water should be removed from streams when flows decline to below recommended limits.

Channel Maintenance

A dominant discharge flow (approximate bankfull capacity, presently undefined) should be maintained for at least a 24-hour period during the spring runoff to maintain channel integrity and redistribute bottom sediments. This necessary flow should be achieved in heavily appropriated streams by bypassing water in a step-wise manner, gradually increasing to and from the dominant discharge. Long-term gauging of stream flows will be necessary to define the required flow specific to each drainage. Recommended discharge for channel maintenance should be legally protected.

Fish Barriers

Debris jams exist on nearly all the study streams, some may act as barriers to migration and should be removed when identified as such. However, debris removal should be conservative because partial blockage of the channel is desirable for cover, pool development and deposition of spawning substrate. Rock barriers exist in the lower reaches of Canyon, Cripple Horse, North Fork Big, West Yaak and Pine creeks. Their removal is not recommended,

but modifications could be made if increased spawning area is needed to enhance recruitment. Passage improvements at the mouth of Pine Creek would be impractical, although limited spawning potential for Kootenai River spawners may exist at the mouth.

Migrant passage during the fall low flow period is especially important in creeks supporting bull trout spawning (e.g., Grave, Libby, Pipe and Quartz creeks, and the Fisher River). Rock and log structures illegally erected to create "swimming holes" should be breached prior to the low flow period when water flows through, rather than over the structures, presenting barriers to migrants.

Tributary Deltas

Delta growth should be monitored at the mouths of Dunn, Libby, Pipe and Quartz creeks and materials should be removed if passage of spawning migrants becomes inhibited. Topographic mapping of the alluvial fan on Quartz Creek was performed using surveying techniques. This procedure should be repeated in five years to compare results and determine the rate of deposition. If passage becomes limited, the feasibility of temporarily increasing river flows to remove the deposited substrate could be considered. If this is not practical, mechanical removal may be warranted. Increasing river stage to above the delta elevation (dam discharge 4,050 cfs) from June 1 through September 30 during peak spawning activity could also be used to enhance migration into spawning areas. This should be done on an annual basis to ensure continued spawning success.

Tributary Habitat

Protection of aquatic habitat in the Kootenai watershed tributaries is of paramount importance to the maintenance of the resident fishery resource. This report summarizes research to support efforts to maintain stream flow conditions favorable to fish production. Hydrologically, the upper (lower-order) reaches in the Kootenai drainage exhibit poor channel stability due to steep, easily erodable banks and high gradients. These factors, combined with extreme peak flows, tend toward increased bed load and sediment movement to the downstream reaches.

Man's activities including timber harvest, mining and road construction in many cases are concentrated in the upper watershed areas. Private forest industry is harvesting timber at an accelerated rate and the Kootenai National Forest's ten-year plan projects the construction of 3,750 miles of new roads and the harvest of an additional 2.3 billion board feet of timber. Sediment input to streams results because of poor land management practices, cattle grazing in the riparian zone and road construction along stream courses (Rasmussen and Culwell 1978). Pollutants, toxic to aquatic organisms, may enter streams from mining operations (Schmidt and Botz 1978). Metal and sediment

pollution, and channel instability problems continue to threaten the health of the fishery resource. A comprehensive approach by cooperating land management agencies is needed to assess the extent of present environmental degradation and determine methods for eliminating harmful factors.

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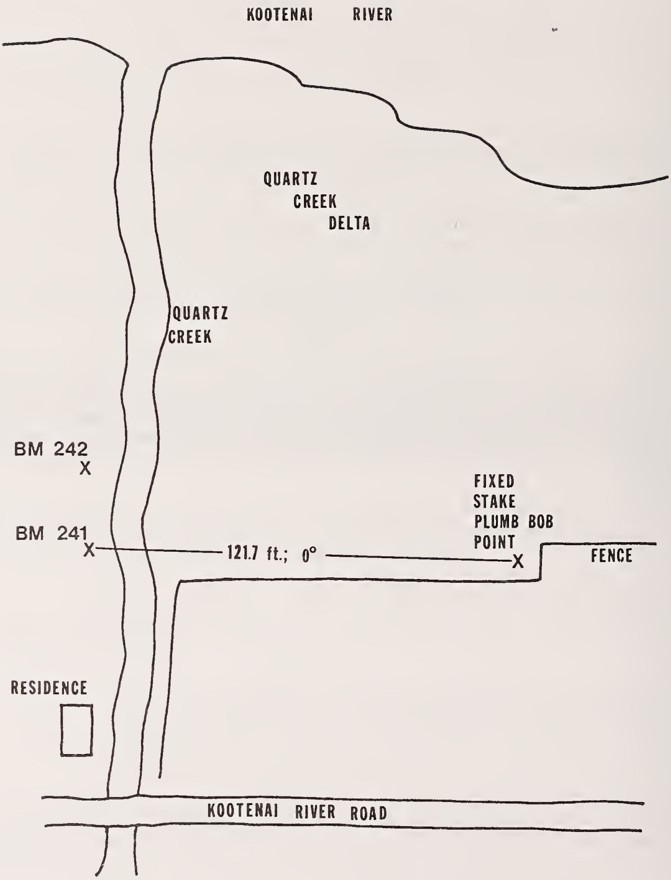
APPENDIX A

Quartz Creek delta topography was measured during April 1987. Raw data and associated graphics are presented for a series of radial transects originating at an established plumb bob point. Elevation measurements were corrected to the bench mark #241 +100 feet.



Appendix A1. An aerial schematic of the Quartz Creek delta showing relative location of the established plumb bob point, bench mark #241 and auxiliary bench mark #242.

Appendix A2. Topographic measurements of the Quartz Creek delta through the primary distributary.

Longitudinal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a]
0	14.95	85.93
2	15.06	85.82
4	14.95	85.93
6	14.95	85.93
8	14.88	86.00
10	14.89	85.99
12	15.03	85.85
14	14.92	85.96
16	14.88	86.00
18	14.91	85.97
20	14.90	85.98
22	14.87	86.01
24	14.90	85.98
26	15.17	85.71
28	15.06	85.82
30	15.20	85.68
32	15.68	85.20
34	15.60	85.28
36	15.73	85.15
38	16.05	84.83
40	16.40	84.48
42	16.51	84.37
44	16.46	84.42
46	16.43	84.45
48	16.78	84.10
50	17.40	83.48
52	17.90	82.98

[a] Elevation = (Bench Mark #241 Elevation (0.88) +100) - Stadia rod reading.

Appendix A3. Topographic measurements of the Quartz Creek delta along the 0° bearing, originating at the plumb bob point.

Horizontal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a]
8.0	7.14	94.02
18.0	8.51	92.65
23.0	8.35	92.81
32.0	7.49	93.67
46.0	7.18	93.98
54.0	6.64	94.52
59.0	6.84	94.32
61.0	6.78	94.38
67.0	9.66	91.50
76.0	9.80	91.36
89.0	10.65	90.51
95.0	10.24	90.92
101.0	8.97	92.19
107.0	3.37	97.79
115.5	2.73	98.43
121.7 (distance to BM 241)		

a/ Elevation = (Bench Mark #241 Elevation (1.16) +100) - Stadia rod reading.

Appendix A4. Topographic measurements of the Quartz Creek delta along the 35° bearing, originating at the plumb bob point.

Horizontal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a]
8.0	6.46	94.70
17.0	8.30	92.86
24.0	8.55	92.61
34.0	7.57	93.59
49.0	7.04	94.12
58.0	7.16	94.00
67.0	8.92	92.24
77.0	9.38	91.78
86.0	9.48	91.68
95.0	9.90	91.26
105.0	10.83	90.33
114.0	12.77	88.39
121.0	13.40	87.76
130.0	11.87	89.29
133.5	10.98	90.18
139.0	8.93	92.23
157.0	8.83	92.33
186.0	9.84	91.32
224.0	10.23	90.93
237.0	10.97	90.19
257.0	14.72	86.44

a/ Elevation = (Bench Mark #241 Elevation (1.16) +100) - Stadia rod reading.

Appendix A5. Topographic measurements of the Quartz Creek delta along the 50^{o} bearing, originating at the plumb bob point.

Horizontal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a/]
9	6.18	94.98
20	8.57	92.59
30	8.72	92.44
37	7.88	93.28
45	7.43	93.73
53	7.22	93.94
65	7.49	93.67
70	8.29	92.87
75	9.77	91.39
78	9.84	91.32
81	9.15	92.01
89	9.15	92.01
100	9.64	91.52
110	10.17	90.99
119	10.50	90.66
128	11.50	89.66
131	12.07	89.09
136	12.98	88.18
144	13.37	87.79
153	13.70	87.46
163	13.40	87.76
178	13.70	87.46
195	13.66	87.50
208	13.38	87.78
219	13.75	87.41
227	14.72	86.44
236	16.07	85.09
246	18.08	83.08

[a/] Elevation = (Bench Mark #241 Elevation (1.16) +100) - Stadia rod reading.

Appendix A6. Topographic measurements of the Quartz Creek delta along the 55^{o} bearing, originating at the plumb bob point.

Horizontal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a/]
10	6.48	94.68
22	8.64	92.52
31	8.85	92.31
48	7.33	93.83
71	7.77	93.39
81	9.94	91.22
86	10.13	91.03
91	9.33	91.83
107	9.80	91.36
122	9.98	91.18
137	10.49	90.67
145	11.71	89.45
148	12.10	89.06
159	13.60	87.56
169	15.00	86.16
179	14.82	86.34
189	14.14	87.02
199	14.03	87.13
210	14.42	86.74
220	14.04	87.12
230	14.68	86.48
240	17.16	84.00

[a/] Elevation = (Bench Mark #241 Elevation (1.16) +100) - Stadia rod reading.

Appendix A7. Topographic measurements of the Quartz Creek delta along the 60^{o} bearing, originating at the plumb bob point.

Horizontal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a/]
8.0	6.00	95.16
16.0	7.33	93.83
21.5	8.39	92.77
26.5	8.96	92.20
31.0	9.17	91.99
41.5	8.30	92.86
51.5	7.38	93.78
61.5	7.32	93.84
71.5	7.38	93.78
76.0	7.85	93.31
83.0	9.19	91.97
88.0	9.91	91.25
90.5	10.41	90.75
95.0	10.23	90.93
105.0	9.58	91.58
113.0	10.01	91.15
116.5	10.16	91.00
124.0	10.05	91.11
134.0	10.15	91.01
144.0	10.15	91.01
154.0	10.54	90.62
164.0	11.33	89.83
170.0	11.90	89.26
174.0	12.24	88.92
176.0	12.48	88.68
184.0	14.50	86.66
194.0	15.16	86.00
199.0	15.26	85.90
205.0	15.14	86.02
210.0	14.85	86.31
215.0	14.76	86.40
220.0	14.76	86.40
225.0	14.54	86.62
230.0	14.90	86.26
235.0	15.48	85.68
240.0	17.00	84.16
245.0	18.36	82.80

[a/] Elevation = (Bench Mark #241 Elevation (1.16) +100) - Stadia rod reading.

Appendix A8. Topographic measurements of the Quartz Creek delta along the 70° bearing, originating at the plumb bob point.

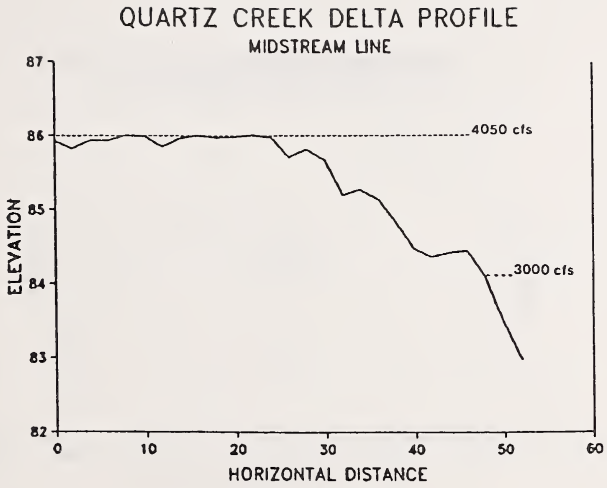
Horizontal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a]
9.0	5.46	95.56
15.0	6.64	94.38
25.5	6.86	94.16
32.5	9.21	91.81
37.5	9.22	91.80
41.0	9.08	91.94
43.0	8.49	92.53
50.5	7.84	93.18
60.5	7.27	93.75
63.5	7.19	93.83
72.5	7.50	93.52
80.5	8.10	92.92
86.0	8.51	92.51
93.0	8.96	92.06
96.0	9.23	91.79
101.0	9.40	91.62
105.5	9.82	91.20
111.0	10.23	90.79
116.0	10.68	90.34
121.0	11.10	89.92
127.0	11.29	89.73
133.0	11.41	89.61
141.5	10.92	90.10
152.5	10.50	90.52
162.5	11.18	89.84
171.5	12.19	88.83
181.5	13.10	87.92
191.0	14.05	86.97
194.5	14.50	86.52
198.0	14.55	86.47
201.0	14.05	86.97
204.0	13.90	87.12
214.0	14.06	86.96
224.0	14.55	86.47
234.0	15.52	85.50
238.0	15.75	85.27
242.0	16.00	85.02

[a] Elevation = (Bench Mark #241 Elevation (1.16) +100) - Stadia rod reading.

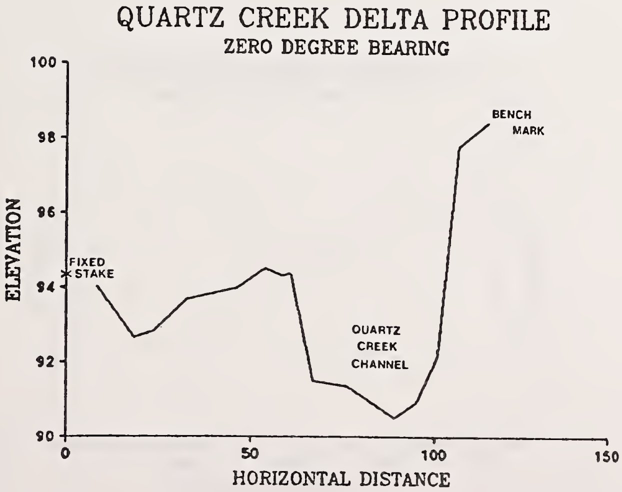
Appendix A9. Topographic measurements of the Quartz Creek delta along the 110^{o} bearing, originating at the plumb bob point.

Horizontal Distance (ft)	Stadia Rod Reading (ft)	Elevation[a/]
10.0	5.12	96.04
20.0	6.24	94.92
30.0	7.18	93.98
40.0	7.74	93.42
50.0	7.94	93.22
56.5	8.01	93.15
60.0	7.88	93.28
64.5	8.58	92.58
74.0	8.98	92.18
78.0	9.15	92.01
88.0	10.08	91.08
100.0	9.93	91.23
110.0	10.52	90.64
120.0	10.64	90.52
126.0	10.69	90.47
136.0	10.73	90.43
146.0	10.83	90.33
156.0	10.67	90.49
164.0	10.52	90.64
168.0	10.70	90.39
180.0	11.67	89.49
190.0	12.69	88.47
193.0	13.34	87.82
198.0	13.83	87.33
206.0	14.10	87.06
217.0	15.09	86.07
225.0	15.63	85.53
235.0	16.73	84.43

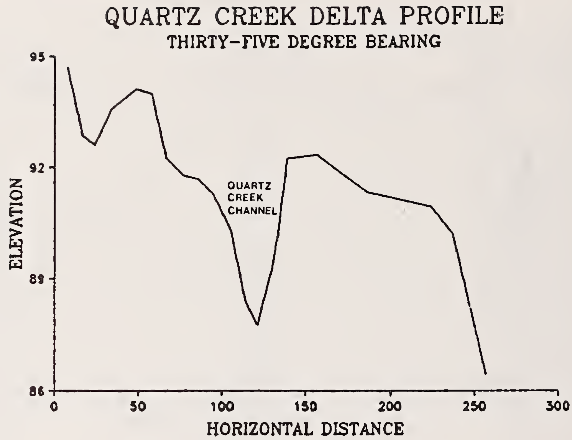
[a/] Elevation = (Bench Mark #241 Elevation (1.16) +100) - Stadia rod reading.



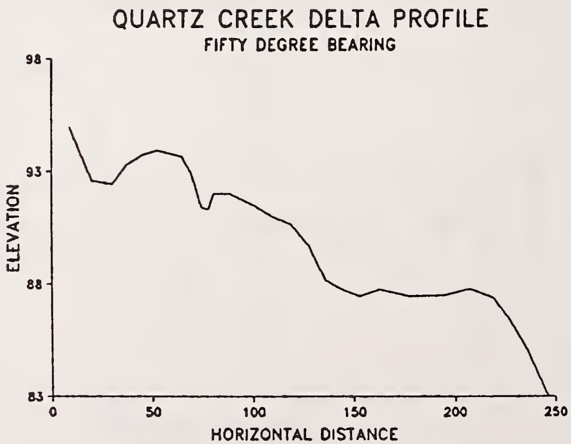
Appendix A10. A cross-sectional view of the Quartz Creek delta through the primary distributary.



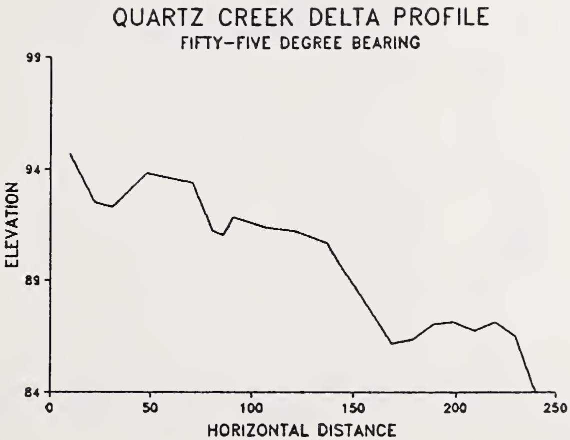
Appendix A11. A cross-sectional view of the Quartz Creek delta along the 0° bearing, from the plumb bob point to the bench mark #241.



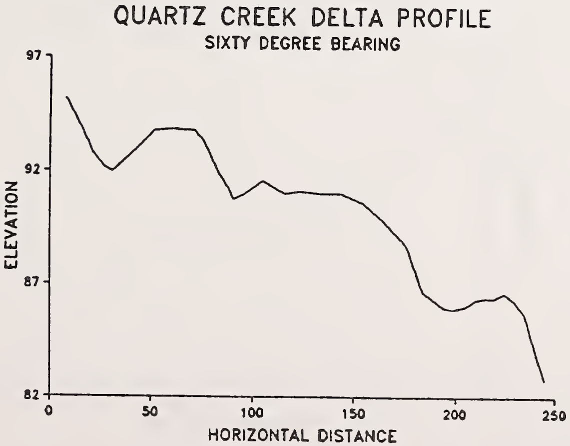
Appendix A12. A cross-sectional view of the Quartz Creek delta along the 35^{o} bearing, from the plumb bob point to the bench mark #241.



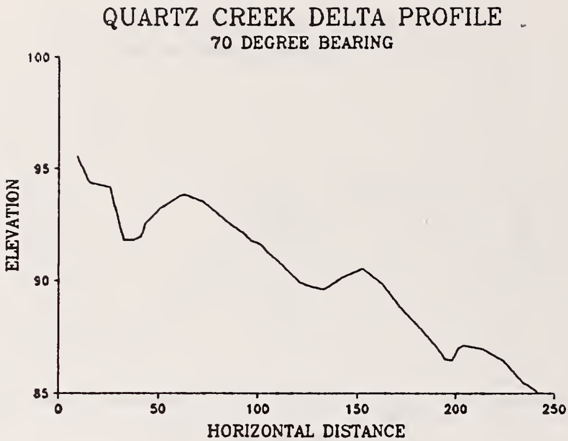
Appendix A13. A cross-sectional view of the Quartz Creek delta along the 50^{o} bearing, from the plumb bob point to the bench mark #241.



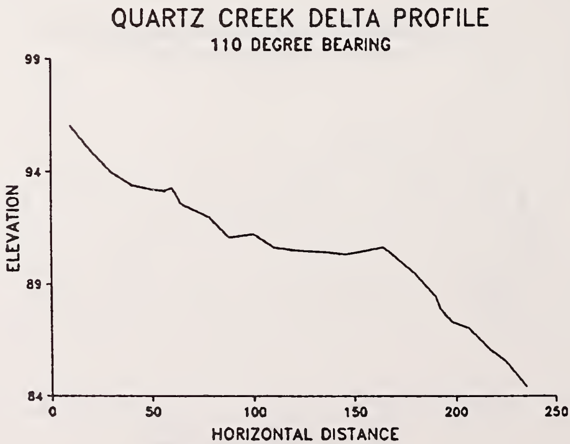
Appendix A14. A cross-sectional view of the Quartz Creek delta along the 55^{o} bearing, from the plumb bob point to the bench mark #241.



Appendix A15. A cross-sectional view of the Quartz Creek delta along the 60^{o} bearing, from the plumb bob point to the bench mark #241.



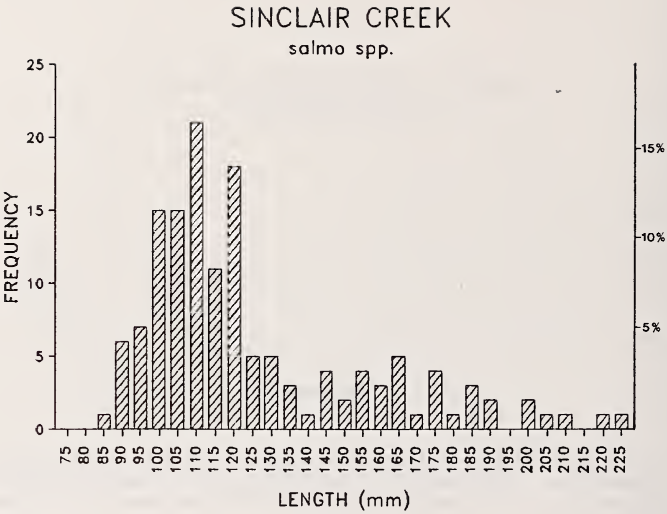
Appendix A16. A cross-sectional view of the Quartz Creek delta along the 70° bearing, from the plumb bob point to the bench mark #241.



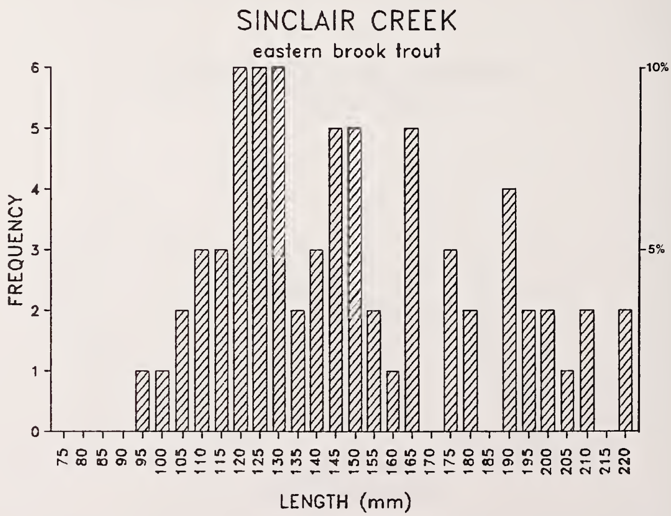
Appendix A17. A cross-sectional view of the Quartz Creek delta along the 110° bearing, from the plumb bob point to the bench mark #241.

APPENDIX B

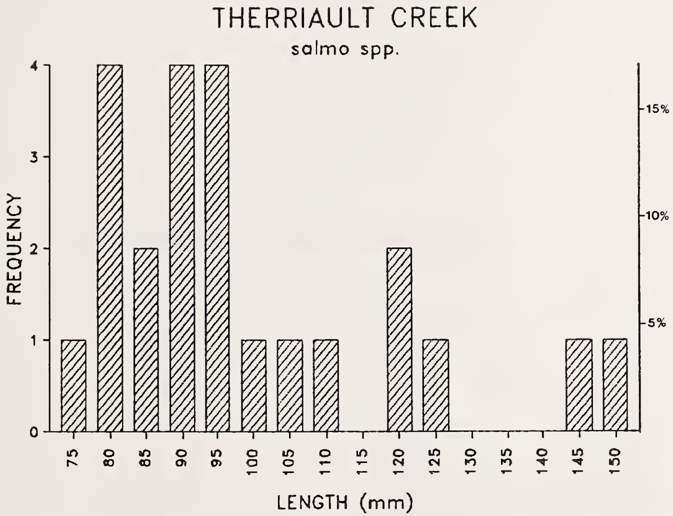
Length-frequency histograms of fish captured in the study tributaries. The number of captures in each length category are presented on the Y axis to the left. Percentages are located on the right.



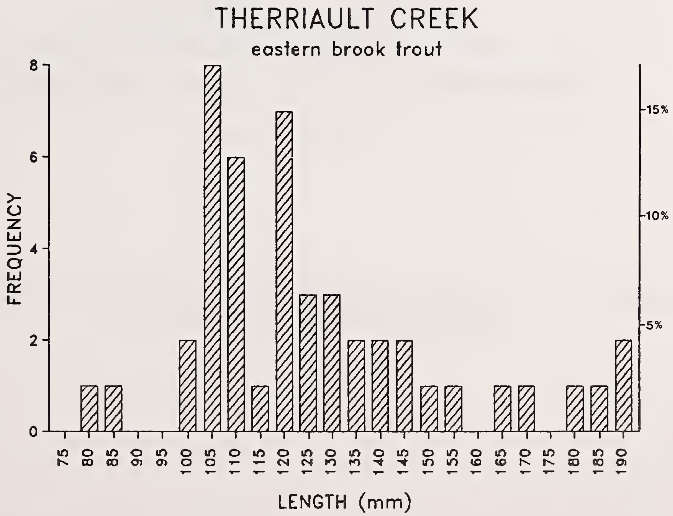
Appendix B1. The length distribution of Salmo spp. captured in Sinclair Creek.



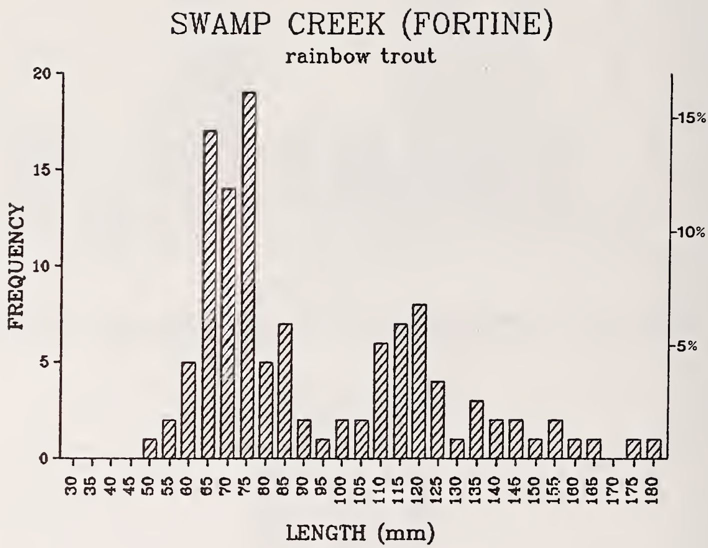
Appendix B2. The length distribution of eastern brook trout captured in Sinclair Creek.



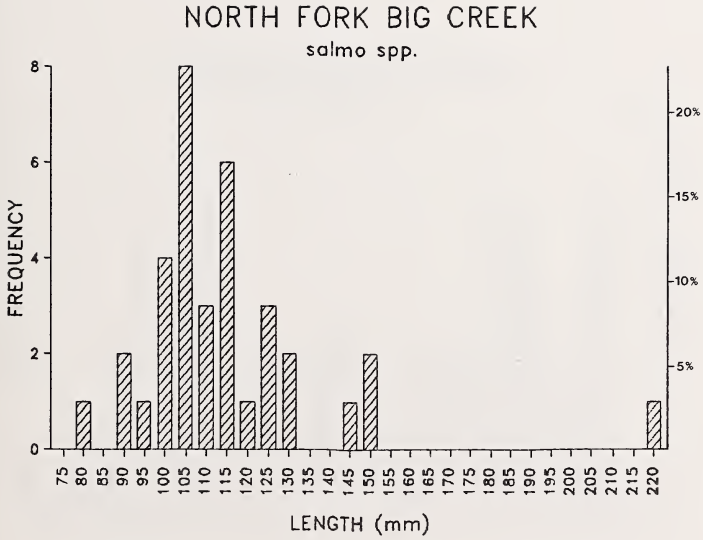
Appendix B3. The length distribution of <u>Salmo</u> spp. captured in Therriault Creek.



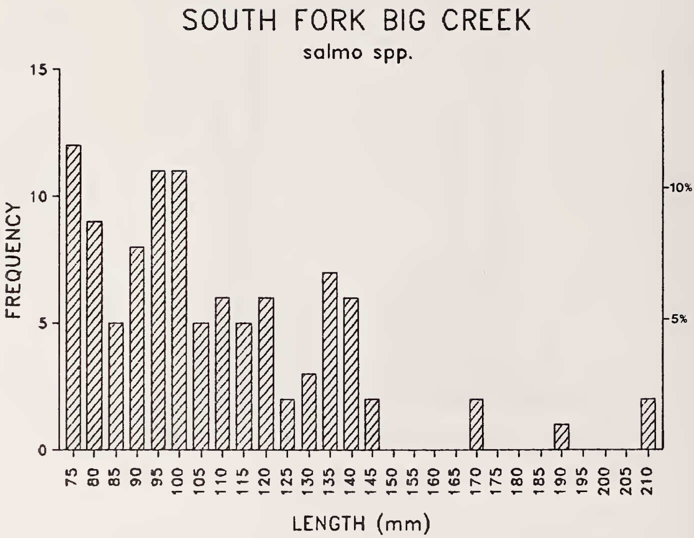
Appendix B4. The length distribution of eastern brook trout captured in Therriault Creek.



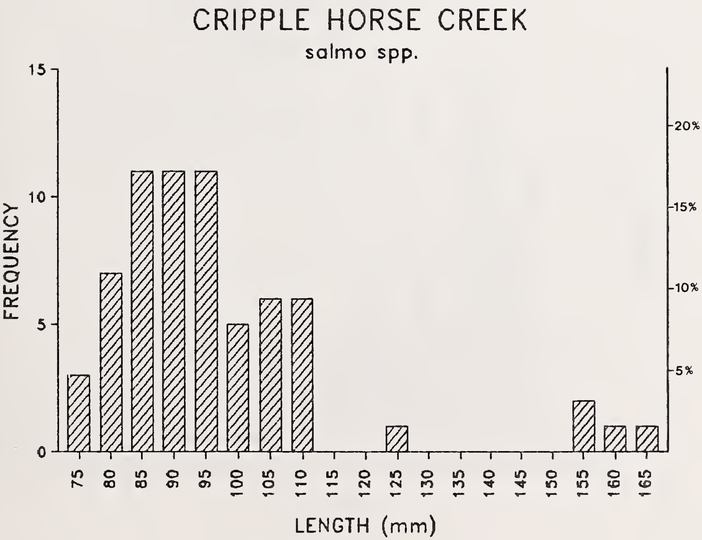
Appendix B5. The length distribution of rainbow trout captured in Swamp Creek (Fortine).



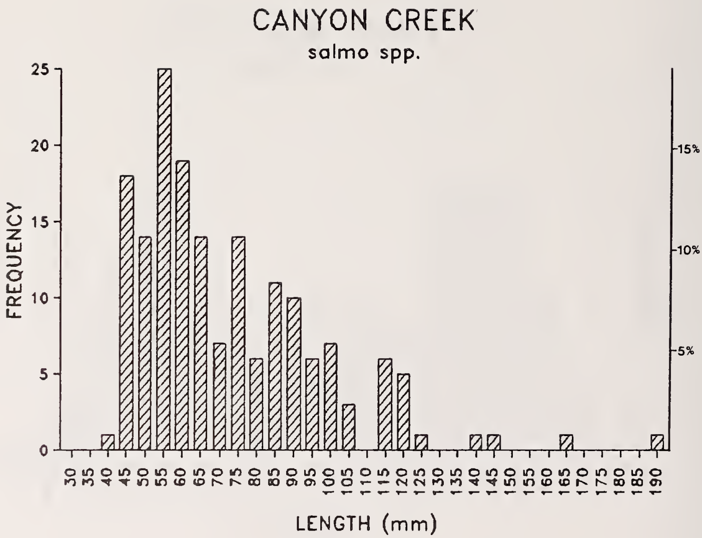
Appendix B6. The length distribution of <u>Salmo</u> spp. captured in North Fork Big Creek.



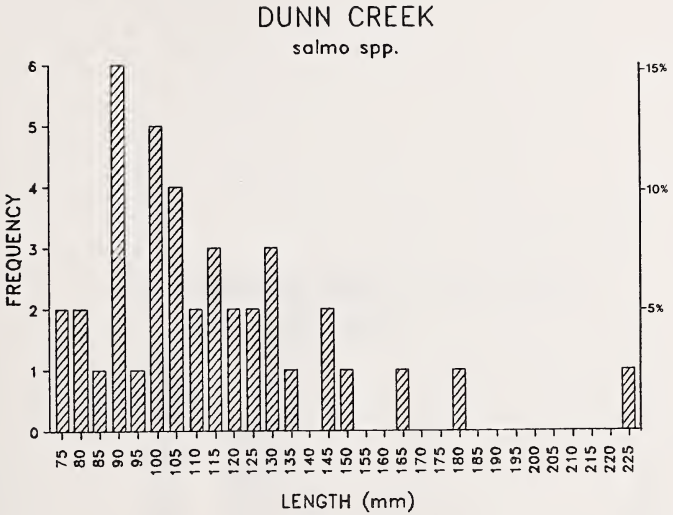
Appendix B7. The length distribution of _Salmo_ spp. captured in South Fork Big Creek.



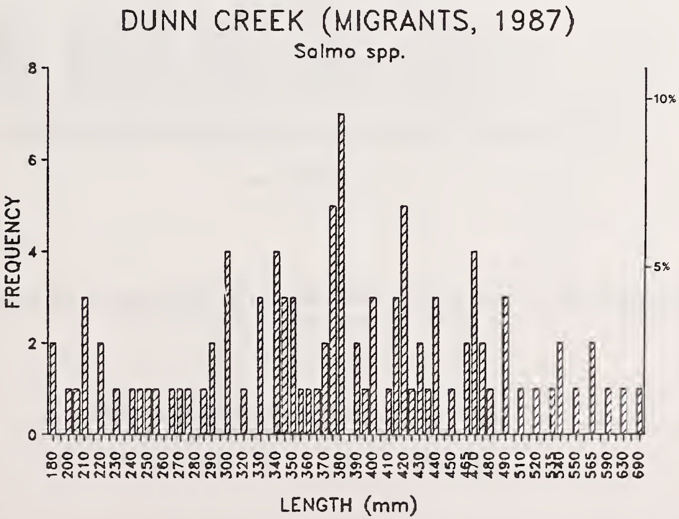
Appendix B8. The length distribution of Salmo spp. captured in Cripple Horse Creek.



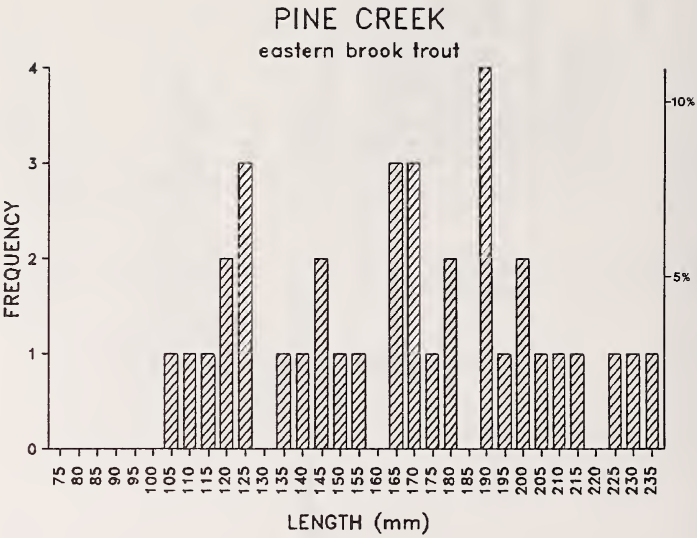
Appendix B9. The length distribution of Salmo spp. captured in Canyon Creek.



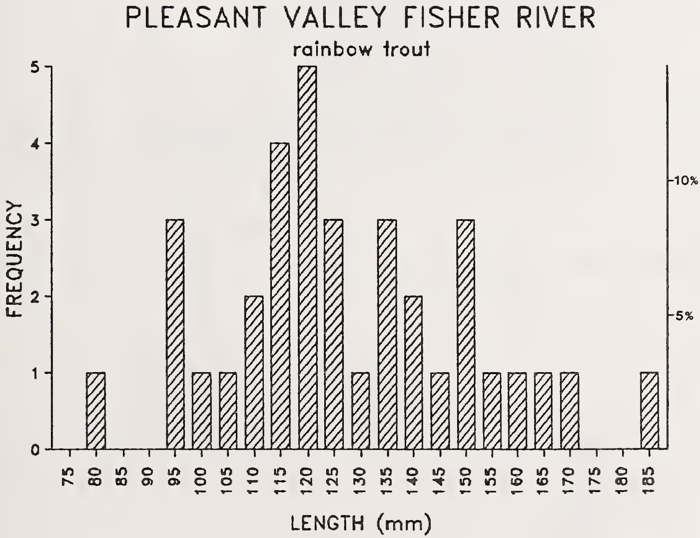
Appendix B10. The length distribution of resident Salmo spp. captured in Dunn Creek.



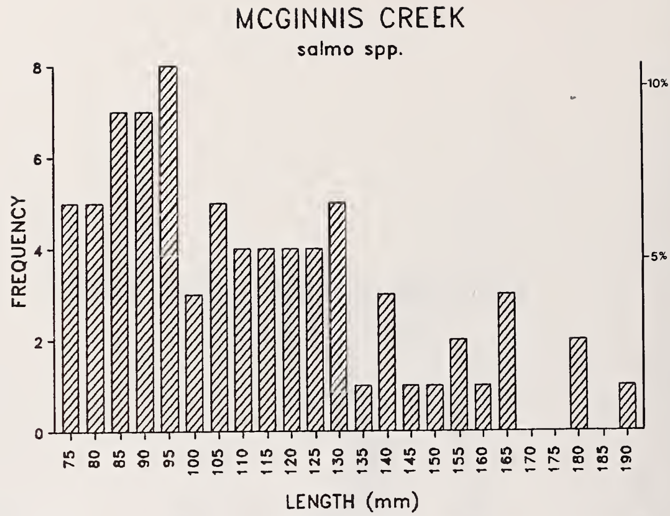
Appendix B11. The length distribution of migrant Salmo spp. captured in Dunn Creek.



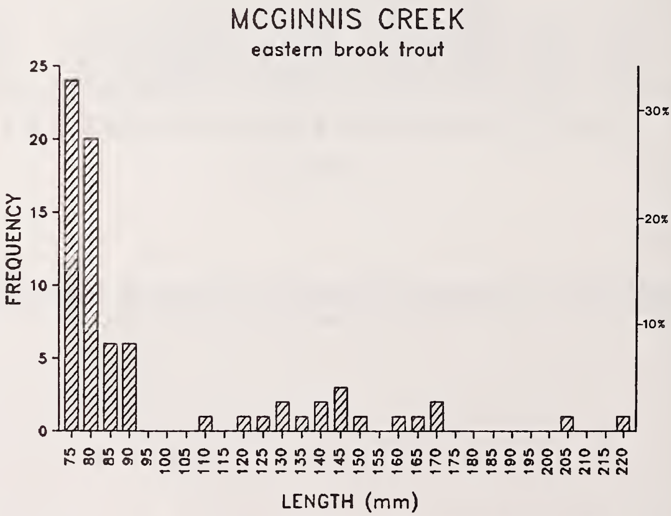
Appendix B12. The length distribution of eastern brook trout captured in Pine Creek.



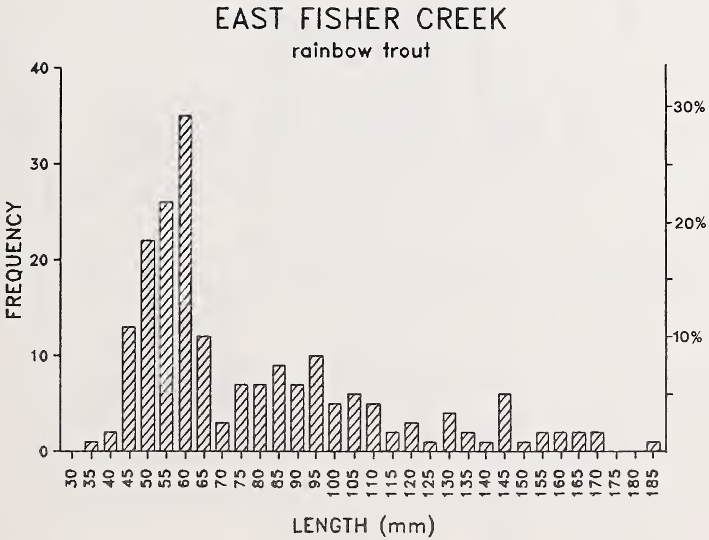
Appendix B13. The length distribution of rainbow trout captured in Pleasant Valley Fisher River.



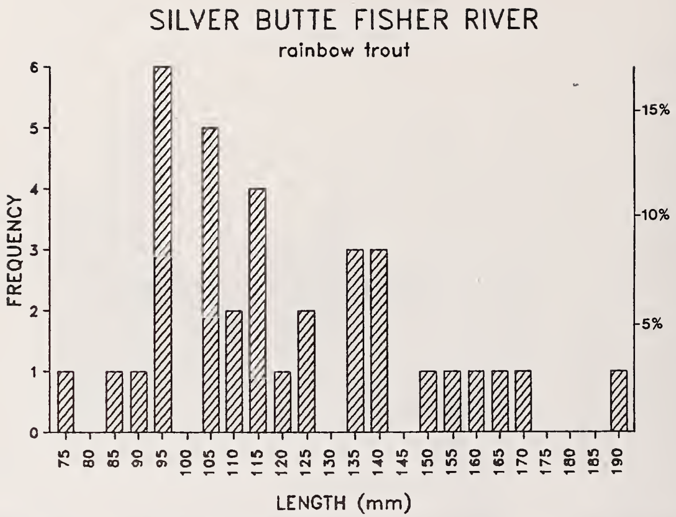
Appendix B14. The length distribution of Salmo spp. captured in McGinnis Creek.



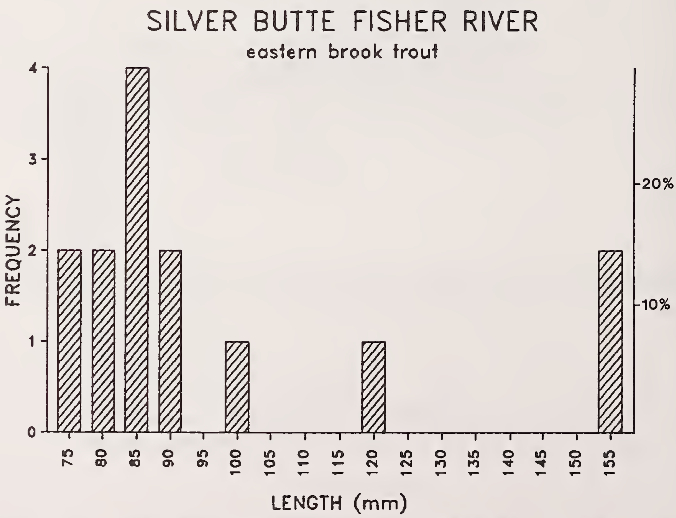
Appendix B15. The length distribution of eastern brook trout captured in McGinnis Creek.



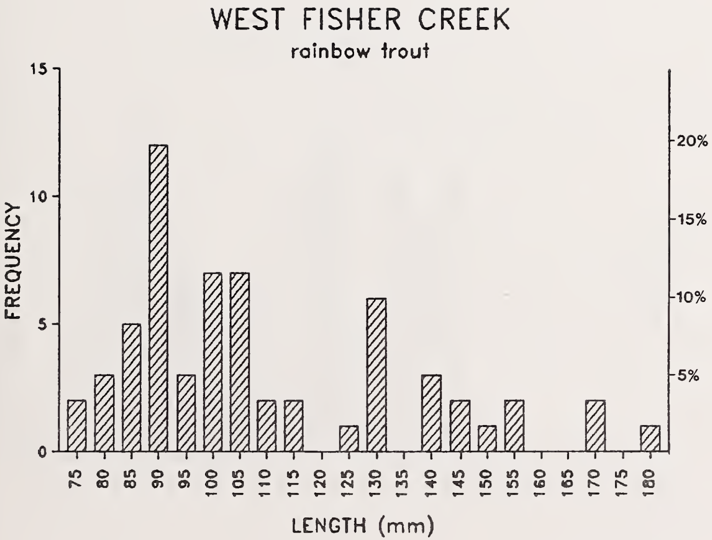
Appendix B16. The length distribution of rainbow trout captured in East Fisher River.



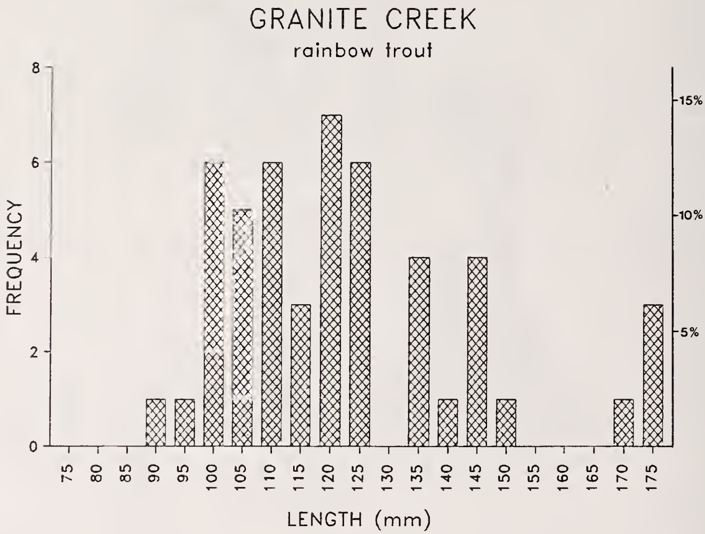
Appendix B17. The length distribution of rainbow trout captured in Silver Butte Fisher River.



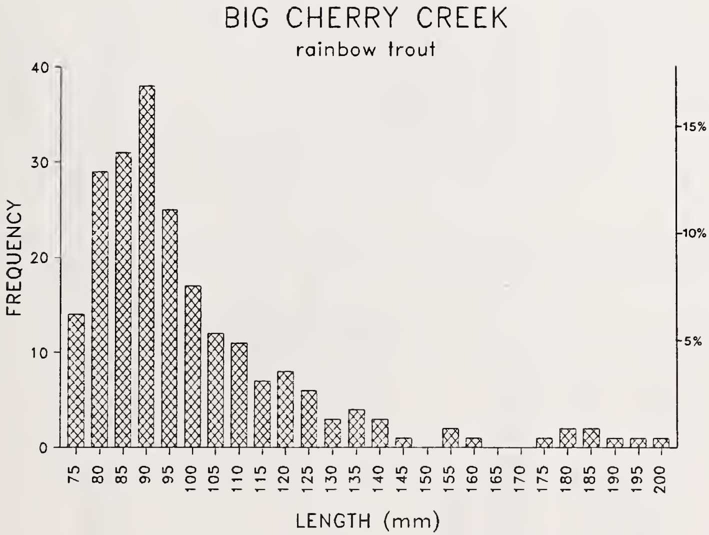
Appendix B18. The length distribution of eastern brook trout captured in Silver Butte Fisher River.



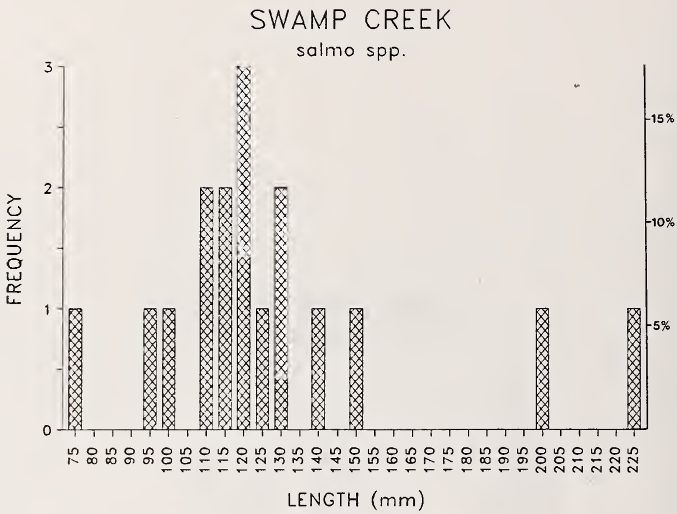
Appendix B19. The length distribution of rainbow trout captured in West Fisher Creek.



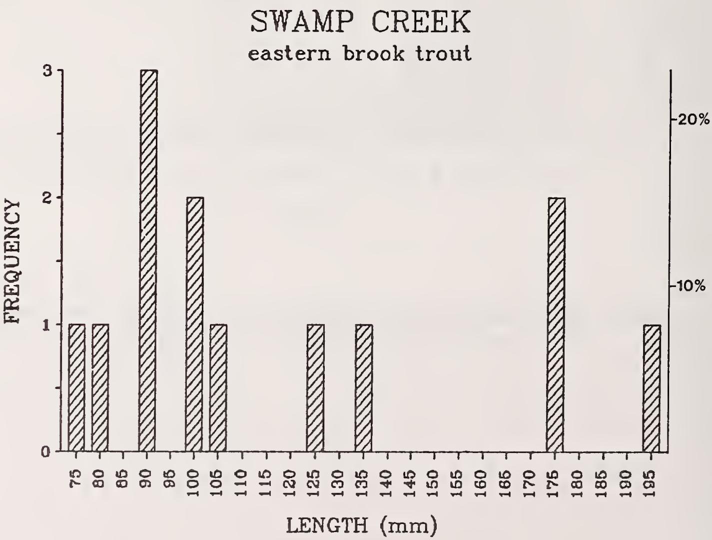
Appendix B20. The length distribution of rainbow trout captured in Granite Creek.



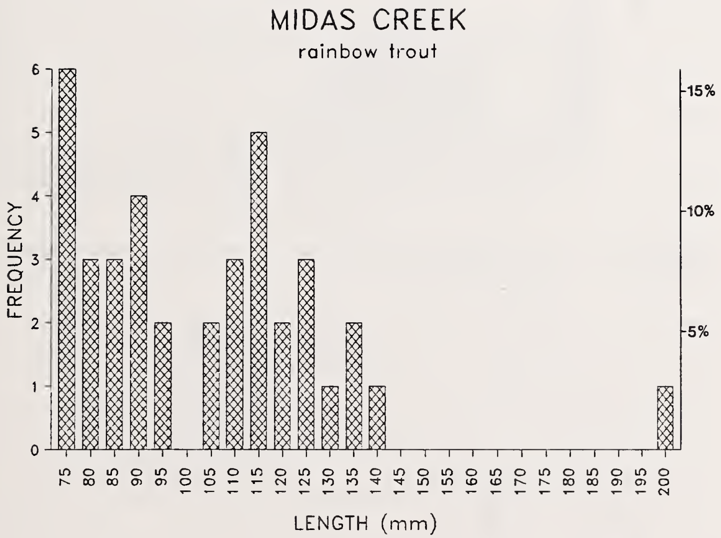
Appendix B21. The length distribution of rainbow trout captured in Big Cherry Creek.



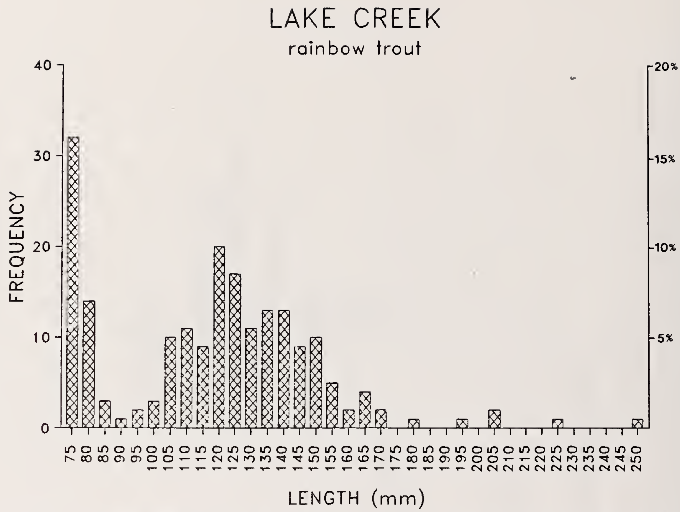
Appendix B22. The length distribution of Salmo spp. captured in Swamp Creek (Libby).



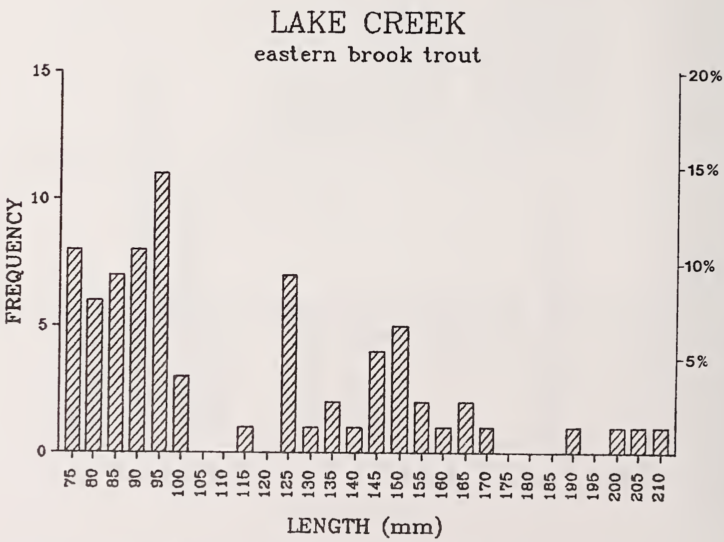
Appendix B23. The length distribution of eastern brook trout captured in Swamp Creek (Libby).



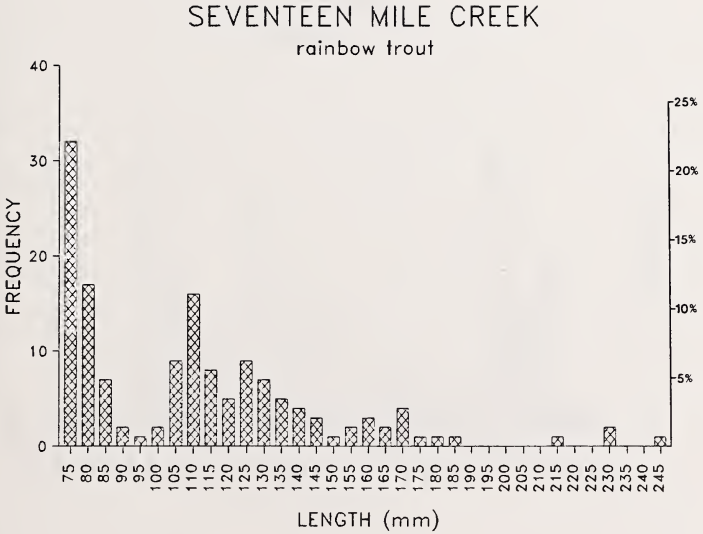
Appendix B24. The length distribution of rainbow trout captured in Midas Creek.



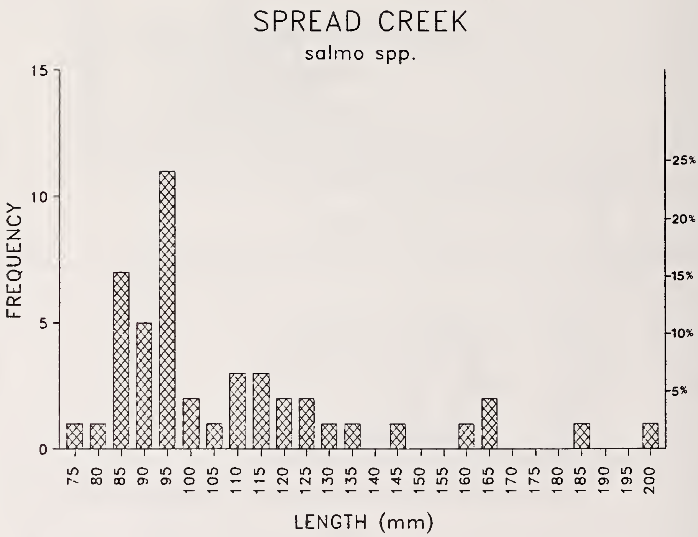
Appendix B25. The length distribution of rainbow trout captured in Lake Creek.



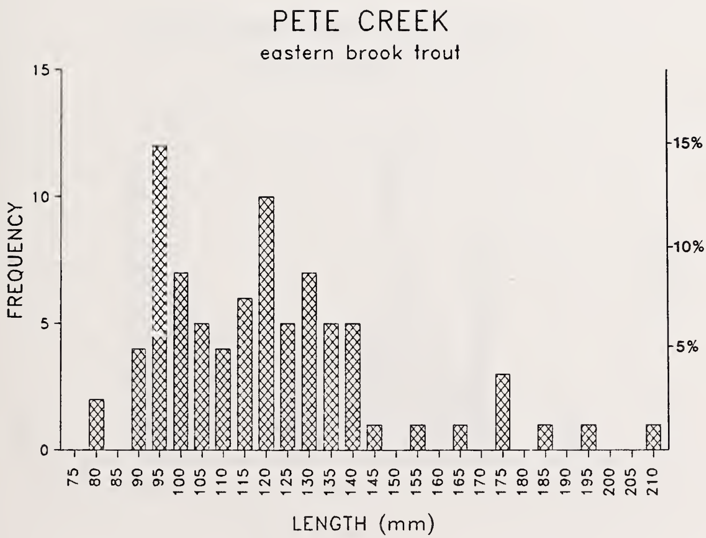
Appendix B26. The length distribution of eastern brook trout captured in Lake Creek.



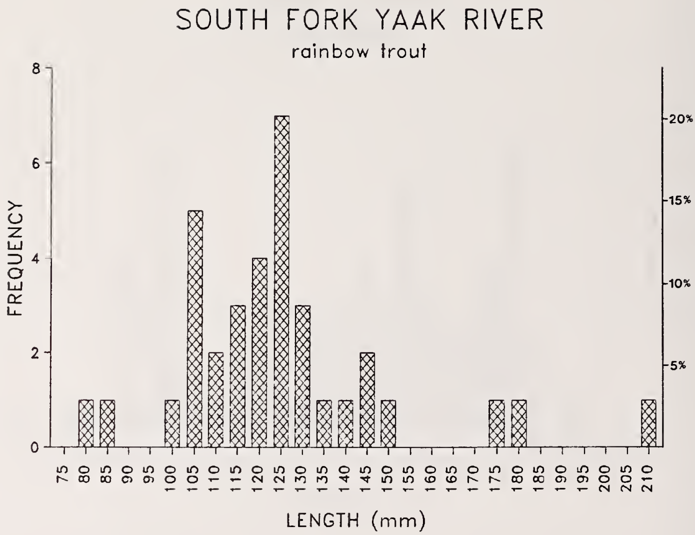
Appendix B27. The length distribution of rainbow trout captured in Seventeenmile Creek.



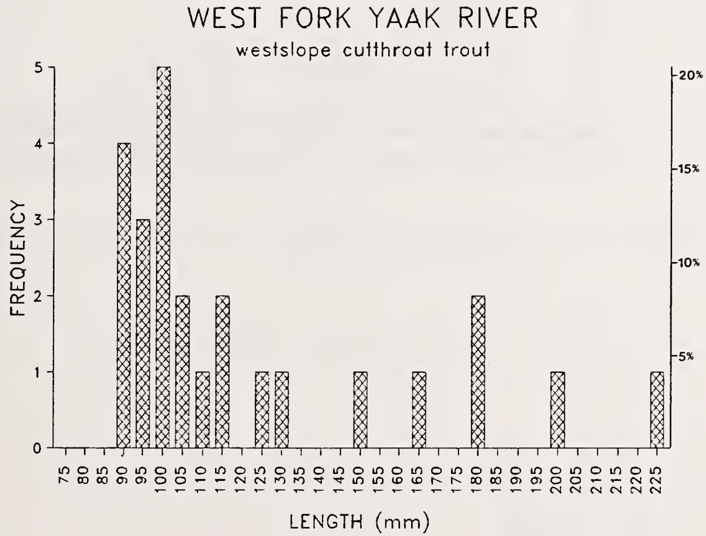
Appendix B28. The length distribution of Salmo spp. captured in Spread Creek.



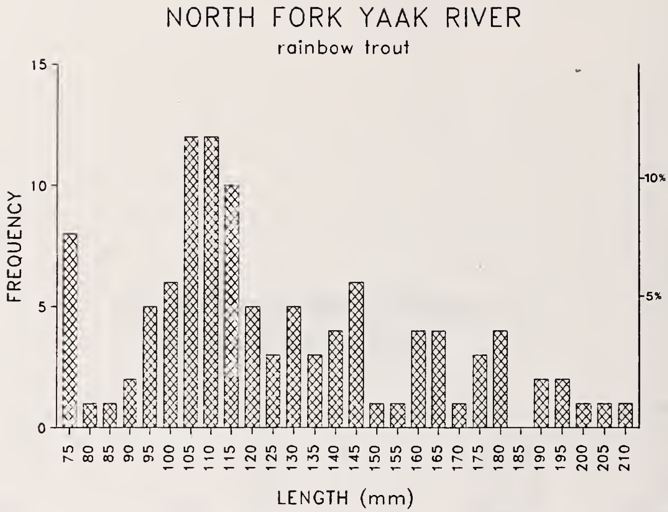
Appendix B29. The length distribution of eastern brook trout captured in Pete Creek.



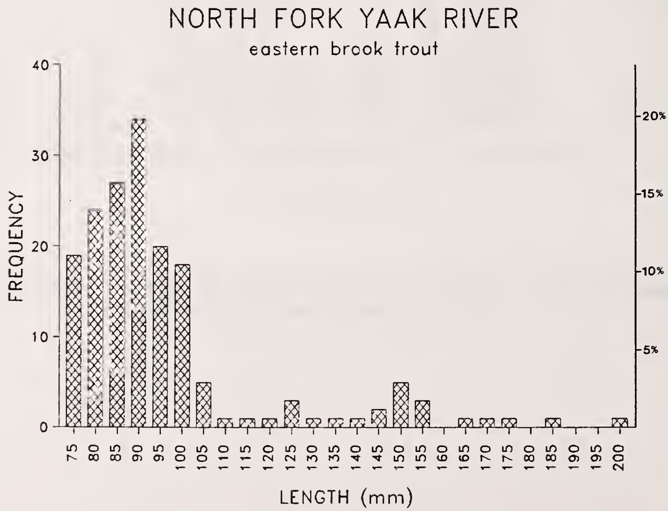
Appendix B30. The length distribution of rainbow trout captured in South Fork Yaak River.



Appendix B31. The length distribution of westslope cutthroat trout captured in West Fork Yaak River.



Appendix B32. The length distribution of rainbow trout captured in North Fork Yaak River.



Appendix B33. The length distribution of eastern brook trout captured in North Fork Yaak River.

APPENDIX C

Fishery information, compiled by Montana Department of Fish, Wildlife and Parks, pertaining to streams under investigation.

Appendix C1. Fishery information, compiled by Montana Department of Fish, Wildlife and Parks, pertaining to streams under investigation.

Stream Name	Fisheries Information	Coordinates of Study Site	Species[a]	Estimate[b]	Date	Associated Discharge (cfs)
North Fork Big Creek	2-pass estimate	T35N, R30W, S28	Salmo spp. WCT = 60% RB = 37% HYB = 3%	175 minimum	07/28/87	5.1
South Fork Big Creek	2-pass estimate	T35N, R30W, S33	Salmo spp. RB = 76% WCT = 15% HYB = 10%	678 ±116/km	07-27-87	7.7
Big Cherry Creek	mark-recapture estimate	T29N, R31W, S27	RB	1,227 ±131/km	08/24/87	11.7
Canyon Creek	2-pass estimate	T31N, R29W, S22	Salmo spp. RB = 44% WCT = 35% HYB = 12%	229 minimum	07/15/87	0.2
	2-pass estimate	T31N, R29W, S22	Salmo spp.	343 ±243/km (≥75 mm) 1,829 ±229/km (<75 mm)	10/09/87	0.1
	redd survey	mouth to 1.8 km upstream		9	Spring 1979	
	redd survey			10	Spring 1982	
	redd survey			7	Spring 1983	
	redd survey			14	Spring 1984	
	redd survey			16	Spring 1985	

a/ Species codes are as follows: WCT = westslope cutthroat trout, RB = rainbow trout, HYB = WCT x RB hybrid, DV = bull trout, EBT = eastern brook trout.
b/ Confidence intervals are P = 0.95 unless noted "minimum."

Appendix C1. Continued.

Stream Name	Fisheries Information	Coordinates of Study Site	Species[a/]	Estimate[b/]	Date	Associated Discharge (cfs)
Cripple Horse Creek	2-pass estimate	T31N, R28W, S1	*Salmo* spp. RB = 52% WCT = 37% HYB = 11%	517 ±110/km	07-20-87	1.9
Dunn Creek	3-pass estimate	T30N, R29W, S9	RB	312 ±152/km	07/16/87	2.5
	migrant trap maximum likelihood estimate	T30N, R29W, S9	*Salmo* spp. RB = 91% WCT = 4% HYB = 5%	175 (125-297) migrants	04/15/87 to 07/24/87	
East Fisher Creek	mark-recapture estimate	T26N, R29W, S30	RB	638 ±310/km	08/12/87	10.5
Granite Creek	3-pass estimate	T29N, R31W, S3	RB	335 ± 61/km	08/09/87	11.7
Keeler Creek	2-pass estimate	T30N, R33W, S19	DV EBT RB	75 ± 6/km 100 ± 50/km 38 minimum	08/31/87	17.1
	migrant trap	T30N, R33W, S19	DV	11 minimum	06/17/77 to 10/27/77	

a/ Species codes are as follows: WCT = westslope cutthroat trout, RB = rainbow trout, HYB = WCT x RB hybrid, DV = bull trout, EBT = eastern brook trout.

b/ Confidence intervals are P = 0.95 unless noted "minimum."

Appendix C1. Continued.

Stream Name	Fisheries Information	Coordinates of Study Site	Species[a/]	Estimate[b/]	Date	Associated Discharge (cfs)
Lake Creek	mark-recapture estimate	T31N, R33W, S32	RB	205 ± 18/km	09/14/87	118.0
			EBT	39 minimum		
		T29N, R33W, S6	RB	224 ± 83/km	09/74	
			EBT	148 ± 28/km		
McGinnis Creek	2-pass estimate	T26N, R29W, S1	RB	277 ± 77/km	07/14/87	8.3
			EBT	266 ± 74/km		
Midas Creek	2-pass estimate	T28N, T38W, S31	RB	246 ±104/km	07/08/87	0.65
Pete Creek	2-pass estimate	T36N, R32W, S29	EBT	539 ± 20/km	09/02/87	2.7
			WCT	80 ± 53/km		
Pine Creek	2-pass estimate	T33N, R34W, S27	EBT	320 ±160/km	07/20/87	
Pleasant Valley Fisher River	2-pass estimate	T26N, R29W, S1	RB	152 ± 62/km	08/19/87	24.0
Seventeenmile Creek	3-pass estimate	T34N, R33W, S26	RB	982 ±148/km	09/16/87	7.5
	migrant trap minimum estimate	T34N, R33W, S27	RB	35	Spring 1987	
Silver Butte Fisher River	3-pass estimate	T26N, R29W, S17	RB	267 ±144/km	08/26/87	15.5
			EBT	78 minimum		
Sinclair Creek	2-pass estimate	T36N, R26W, S24	*Salmo* spp.	544 ± 22/km	07/23/87	
			EBT	296 ± 48/km		

a/ Species codes are as follows: WCT = westslope cutthroat trout, RB = rainbow trout, HYB = WCT x RB hybrid, DV = bull trout, EBT = eastern brook trout.

b/ Confidence intervals are P = 0.95 unless noted "minimum."

Appendix C1. Continued.

Stream Name	Fisheries Information	Coordinates of Study Site	Species[a]	Estimate[b]	Date	Associated Discharge (cfs)
Spread Creek	2-pass estimate	T35N, R33W, S3	*Salmo* spp. EBT	370 ±148/km 56 ± 25/km	09/13/87	20.0
Swamp Creek (Libby)	2-pass estimate	T28N, R30W, S4	*Salmo* spp. EBT	153 ± 73/km 190 minimum	09/12/87	3.4
Swamp Creek (Fortine)	2-pass estimate	T33N, R26W, S21	RB	607 ±140/km	09/10/87	1.0
Therriault Creek	2-pass estimate	T35N, R26W, S3	EBT RB	313 minimum 173 ± 53/km	07/22/87	8.5
East Fork Yaak River	2-pass estimate	T37N, R31W, S23	RB EBT	86 ± 33/km 112 ± 53/km	08/27/87	29.8
North Fork Yaak River	3-pass estimate	T37N, R31W, S22	EBT RB	1,060 ± 38/km 661 ± 77/km	09/23/87	12.0
South Fork Yaak River	mark-recapture estimate	T36N, R31W, S1	EBT RB	401 ±213/km 225 ± 94/km	08/13/87	9.2
West Fork Yaak River	2-pass estimate	T37N, R31W, S32	WCT EBT	156 ± 48/km 78 ± 36/km	09/22/87	7.0
West Fisher Creek	2-pass estimate	T27N, R30W, S31	RB	444 ±193/km	09/01/87	12.0

a/ Species codes are as follows: WCT = westslope cutthroat trout, RB = rainbow trout, HYB = WCT x RB hybrid, DV = bull trout, EBT = eastern brook trout.

b/ Confidence intervals are P = 0.95 unless noted "minimum."

APPENDIX D

Flow recommendations for tributaries to the Kootenai drainage required for successful migration, spawning and rearing of game fish.

Appendix D1. Flow recommendations for tributaries to the Kootenai drainage required for successful migration, spawning and rearing of game fish.

Stream Name	Reach Boundaries Lower	Reach Boundaries Upper	Tributary to[a]	Low Flow (cfs)	Dates	Passage Flow (cfs)	Dates
North Fork Big Creek	T35N, R30W, S28	T35N, R30W, S6	BC	14	Jul 16 - Mar 31	27	Apr 1 - Jul 15
South Fork Big Creek	T35N, R30W, S28	T33N, R29W, S27	BC	20	Jul 16 - Mar 31	22	Apr 1 - Jul 15
Big Cherry Creek	T30N, R30W, S2	T28N, R32W, S23	LC	40	Entire Year		
Canyon Creek	T31N, R29W, S22	T30N, R28W, S26	LK	4	Jul 16 - Mar 31	12	Apr 1 - Jul 15
Cripple Horse Creek	T31N, R29W, S2	T31N, R27W, S21	LK	8	Jul 16 - Mar 31	14	Apr 1 - Jul 15
Dunn Creek	T30N, R29W, S9	T26N, R28W, S26	KR	8	Jul 16 - Mar 31	18	Apr 1 - Jul 15
Edna Creek	T33N, R26W, S2	T33N, R27W, S3	FC	3	Jul 1 - Mar 31	22	Apr 1 - Jun 30
East Fisher Creek	T26N, R29W, S30	T25N, R28W, S25	SBFR	15	Jul 1 - Mar 31	35	Apr 1 - Jun 30
Granite Creek	T30N, R30W, S2	T29N, R32W, S27	LC	21	Jun 16 - Apr 30	21	
					May 1 - May 15	50	
					May 16 - May 31	200	
					Jun 1 - Jun 16	50	
Keeler Creek	T30N, R33W, S17	T58N, R3E, S34	LKC	45	Entire Year		
Lake Creek	T31N, R33W, S19	T29N, R33W, S8	KR	140	Jul 16 - Mar 31	140	
					Apr 1 - Apr 15	200	
					Apr 16 - Apr 30	350	
					May 1 - May 15	600	
					May 16 - May 31	1,200	
					Jun 1 - Jun 15	600	
					Jun 16 - Jun 30	350	
					Jul 1 - Jul 15	200	

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Appendix D1. Continued.

Stream Name	Reach Boundaries		Tributary to[a]	Low Flow (cfs)	Dates	Passage Flow (cfs)	Dates
	Lower	Upper					
McGinnis Creek	T27N, R38W, S1	T25N, R28W, S17	FR	12	Jul 1 - Mar 31	20	Apr 1 - Jun 30
Midas Creek	T28N, R31W, S31	T27N, R31W, S8	LC	1.5	Jul 1 - Mar 31	10	Apr 1 - Jun 30
Pete Creek	T30N, R32W, S5	T37N, R33W, S24	YR	15	Jul 16 - Mar 31	20	Apr 1 - Jul 15
Pine Creek	T33N, R34W, S27	T34N, R34W, S16	KR	5.5	Jul 1 - Mar 31	17	Apr 1 - Jun 30
Pleasant Valley Fisher River	T26N, R30W, S9	T27N, R28W, S27	FR	32	Jul 1 - Mar 31	47	Apr 1 - Jun 30
Seventeenmile Creek	T34N, R33W, S27	T34N, R33W, S7	YR	40	Entire Year		
Silver Butte Fisher River	T26N, R29W, S9	T26N, R30W, S16	FR	34	Entire Year		
Sinclair Creek	T36N, R27W, S14	T37N, R25W, S30	TR	6	Jul 16 - Mar 31	24	Apr 1 - Jul 15
Spread Creek	T35N, R33W, S10	T37N, R34W, S34	YR	50	Entire Year		
Swamp Creek (Libby)	T29N, R30W, S32	T28N, R30W, S4	LC	5	Jul 1 - Mar 31	15.5	Apr 1 - Jun 30
Swamp Creek (Fortine)	T33N, R26W, S21	T33N, R28W, S31	FC	10	Jul 1 - Mar 31	25	Apr 1 - Jun 30
Therriault Creek	T36N, R26W, S32	T36N, R26W, S6	TR	4	Jul 1 - Mar 31	7.5	Apr 1 - Jun 30
West Fisher Creek	T27N, R29W, S30	T26N, R31W, S33	FR	28	Jul 1 - Mar 31	75	Apr 1 - Jun 30
East Fork Yaak River	T37N, R31W, S22	T36N, R29W, S9	YR	14	Jul 1 - Mar 31	27	Apr 1 - Jun 30

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Appendix D1. Continued.

Stream Name	Reach Boundaries		Tributary to[a]	Low Flow (cfs)	Dates	Passage Flow (cfs)	Dates
	Lower	Upper					
North Fork Yaak River	T37N, R31W, S22	T37N, R31W, S4	YR	50	Entire Year		
South Fork Yaak River	T36N, R31W, S35	T34N, R31W, S30	YR	19	Jul 16 - Mar 31	23	Apr 1 - Jul 15
West Fork Yaak River	T36N, R31W, S32	T37N, R33W, S19	YR	30	Entire Year		

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